

SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM

PROCEEDINGS

OF THE

UNITED STATES NATIONAL MUSEUM

VOLUME 109

NUMBERS 3411-3415



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1960

ADVERTISEMENT

The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

The *Proceedings*, begun in 1878, are intended primarily as a medium for the publication of original papers, based on the collections of the National Museum, that set forth newly acquired facts in biology, anthropology, and geology, with descriptions of new forms and revisions of limited groups. Copies of each paper, in pamphlet form, are distributed as published to libraries and scientific organizations and to specialists and others interested in the different subjects.

The dates at which these separate papers are published are recorded in the tables of contents of each of the volumes.

The present volume is the hundred and ninth of this series.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogs of type specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

REMINGTON KELLOGG,
Director, United States National Museum.

CONTENTS

	Pages
KEETON, WILLIAM T. A revision of the milliped genus <i>Brachoria</i> (Polydesmida: Xystodesmidae). Eleven figures. No. 3411, published April 14, 1959	1-58
New species: <i>Brachoria calcaria</i> , <i>B. cedra</i> , <i>B. dentata</i> , <i>B. falcifera</i> , <i>B. hamata</i> , <i>B. hoffmani</i> , <i>B. hubrichti</i> , <i>B. insolita</i> , <i>B. laminata</i> , <i>B. ligula</i> , <i>B. mendota</i> , <i>B. plecta</i> , <i>B. turneri</i> .	
KORMILEV, NICHOLAS A. Notes on Aradidae in the U.S. National Museum (Hemiptera): I. Subfamily Calisiinae. Eighteen figures. No. 3413, published April 20, 1959 . . .	209-222
New species: <i>Calisius gracilis</i> , <i>C. bilobatus</i> , <i>C. insignis</i> , <i>C. longiventris</i> , <i>C. australis</i> , <i>C. hackeri</i> , <i>Calisiopsis minutus</i> , <i>C. brasiliensis</i> .	
MACGINITIE, NETTIE. Marine mollusca of Point Barrow, Alaska. Twenty-seven plates. No. 3412, published September 18, 1959	59-208
New subgenus: <i>Thracia</i> (<i>Lampeia</i>).	
New species: <i>Margarites avenosooki</i> , <i>Thracia adamsi</i> , <i>Mysella sovaliki</i> .	
New name: <i>Neptunea middendorffiana</i> .	
SABROSKY, CURTIS W. Flies of the genus <i>Odinia</i> in the Western Hemisphere (Diptera: Odiniidae). One plate. No. 3414, published May 29, 1959	223-236
New species: <i>Odinia biguttata</i> , <i>O. conspicua</i> , <i>O. betulae</i> , <i>O. coronata</i> , <i>O. parvipunctata</i> .	
WIRTH, WILLIS W., and BLANTON, FRANKLIN S.; Biting midges of the genus <i>Culicoides</i> from Panama (Diptera: Heleidae). Ninety-one figures. No. 3415, published July 29, 1959	237-482
New species: <i>Culicoides antefurcatus</i> , <i>C. crescentis</i> , <i>C. commatis</i> , <i>C. phaeonotus</i> , <i>C. dunni</i> , <i>C. daedaloides</i> , <i>C. pilosus</i> , <i>C. evansi</i> , <i>C. tenulobus</i> , <i>C. azureus</i> , <i>C. volcanensis</i> , <i>C. tetrathyris</i> , <i>C. patulipalpis</i> , <i>C. spurius</i> , <i>C. almirantei</i> .	



PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



SMITHSONIAN INSTITUTION
U. S. NATIONAL MUSEUM

Vol. 109

Washington : 1959

No. 3411

A REVISION OF THE MILLIPED GENUS BRACHORIA
(POLYDESMIDA : XYSTODESMIDAE)

By WILLIAM T. KEETON¹

Introduction

The present paper is an attempt to treat in a systematic manner one of the many groups of Diplopoda where revisionary attention has been sorely needed. Three previously recognized genera of the family Xystodesmidae will be considered. These are *Brachoria* Chamberlin, 1939, *Tucoria* Chamberlin, 1942, and *Anfractogon* Hoffman, 1948. Until the present time, 12 different specific names have been assigned to the genus *Brachoria*, five to *Tucoria*, and one to *Anfractogon*. Though it has long been understood that these three nominal genera are closely related, no attempt has been made to study their relationships carefully and thereby to ascertain the validity of the three generic names.

The primary considerations affecting the course of the present study have been fourfold. First is the consideration of the three genera *Brachoria*, *Tucoria*, and *Anfractogon* and their validity as separate taxonomic entities. Second is the evaluation of all specific names based upon members of this group. Third is the provision of accurate descriptions and illustrations of those forms which appear to be valid. Fourth is the description of all new forms which have been found in the course of this study.

¹ Department of Entomology, Cornell University, Ithaca, N. Y.

Specimens in the collections of the Chicago Natural History Museum, the United States National Museum, the Academy of Natural Sciences of Philadelphia, the Carnegie Museum, and the private collections of Mr. R. L. Hoffman and of the author were examined. Dr. Nell B. Causey of the University of Arkansas kindly lent the type specimens of *Brachoria benderi* and *Tucoria calceata* for study.

Inasmuch as the value and accuracy of a paper such as this depends in large part on certainty of identification, great effort was made to examine the type specimens of previously described species whenever possible. I personally examined the holotypes of the following:

<i>Fontaria indianae</i> Bollman	<i>Tucoria dynama</i> Chamberlin
<i>Fontaria glendalca</i> Chamberlin	<i>Anfractogon tenebrans</i> Hoffman
<i>Fontaria kentuckiana</i> Causey	<i>Tucoria viridicolens</i> Hoffman
<i>Cleptoria splendida</i> Causey	<i>Brachoria hansonii</i> Causey
<i>Brachoria brachypus</i> Chamberlin	<i>Brachoria benderi</i> Causey
<i>Brachoria separanda</i> Chamberlin	<i>Tucoria calceata</i> Causey

Dr. R. V. Chamberlin of the University of Utah was kind enough to compare *Brachoria* specimens sent him by the author with his holotypes of *B. initialis*, *B. eutypa*, and *B. ethotela*. Thus I have been able to examine metatypes of these three species.

Several specimens in the personal collection of R. L. Hoffman are undoubtedly conspecific with *Brachoria electa* Causey.

It is thus apparent that in the course of this study specimens of all the named forms in this genus except *Fontaria ochra* Chamberlin and *Brachoria sequens* Chamberlin have been examined. Personal communications from Dr. Chamberlin have supplied information concerning these two forms.

One thing that in the past has caused much confusion in this group has been the lack of uniformity in the methods of illustrating the male gonopods, which provide the most important taxonomic characters for the group. For each genus, certain appropriate positions of the gonopods should be chosen and care should be taken that all drawings are made from as nearly the same angle as possible. Many needless synonyms would have been avoided if this practice had been followed in the past. With structures as complicated as these, drawings made from different angles can readily give the impression of representing different species, and comparisons are extremely difficult.

The illustrations of the male gonopods used in this paper were made using a binocular microscope fitted with an ocular reticule. The left gonopod was removed from the animal and placed on a bit of cotton submerged in alcohol in a watch glass, great care being taken to orient the gonopod into the precise position required. Most gonopods were then drawn from three views, cephalic, caudal, and mesial. In two instances the mesial view was omitted and a ventral view sub-

stituted for it. In a few cases the caudal view was omitted inasmuch as it did not show any important characters not already shown. The cephalic and caudal views of all species were drawn from as nearly the same angle as possible, and the entire gonopod was shown. In the mesial views, however, no attempt was made to make all drawings from the same angle, the gonopods being oriented so as to show best the distinctive features of that particular species. Only the telopodite portions of the gonopods were shown in the mesial views. All setae were removed in order to show structures more clearly. All drawings were made to the same scale.

In the section of this paper devoted to species of the genus, where descriptions are given for each, the second form to be considered is the type species, *Brachoria initialis*. This form is described at some length and with attention to detail, but the descriptions of all other species are considerably shorter. The description of the type species may be considered to hold for all species of the genus in all details not specifically mentioned in the individual descriptions.

Sincere thanks are extended to Mr. Richard L. Hoffman for his constant help and advice during the course of this work. Mr. Hoffman suggested the subject for this study and lent many of the specimens used. Grateful acknowledgment is made of the constant help, suggestions, and encouragement extended by Dr. E. Craig Turner and Dr. R. D. Ross. I am also grateful to Mrs. J. M. Ogle and Mrs. R. E. Montgomery for aid in typing; to William C. Lund for help in the field; and to Dr. J. McD. Grayson for providing the position that made this study possible. The research for this paper was done in the biology department of Virginia Polytechnic Institute, Blacksburg, Va.

Genus *Brachoria* Chamberlin, 1939

Brachoria Chamberlin, Bull. Univ. Utah, biol. ser., vol. 5, No. 3, p. 3, 1939.

Type: *Brachoria initialis* Chamberlin (= *Brachoria ochra initialis* Chamberlin), by original designation.

Tucoria Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, No. 2, p. 17, 1943. Type: *Fontaria kentuckiana* Causey, by original designation. New synonymy.

Anfractogon Hoffman, Proc. Biol. Soc. Washington, vol. 61, p. 94, 1948. Type: *Anfractogon tenebrans* Hoffman, by original designation.

ORIGINAL DESCRIPTION: The original description of the genus *Brachoria* was very short, mentioning only a few characters. The figure of the gonopods of the type species, *B. initialis*, was considered part of the generic description.

The description was as follows: "Relatively broad forms with wide carinae continuing slant of dorsum. The blade of telepodite simple, distally acuminate, of form shown in figure for genotype; large proximal portion sparsely setose, the distal portion smooth."

FUNDAMENTAL CHARACTERS: All members of this genus are broad with wide carinae or paranota as indicated by Chamberlin. This body form alone is enough to identify a specimen from southeastern United States as belonging to the group of genera of which *Brachoria* is a member. Other characters are needed, however, to separate *Brachoria* from closely related genera such as *Apheloria* and *Sigmoria*.

The original drawing of the male gonopods of the type species, *Brachoria initialis*, indicated that the telopodite portion of the gonopod forms an are similar to that in related genera. There was one rather striking distinctive feature, however. This was the presence of a joint or cingulum (new term, from the Latin "cingulum," a girdle) in the telopodite, dividing it into a proximal setose portion and a distal glabrous portion. The presence of this cingulum has been used by all later workers as a distinctive generic character of *Brachoria*.

The later-described genera *Tucoria* Chamberlin and *Anfractogon* Hoffman also had a cingulum and were respectively distinguished from *Brachoria* by the greater bulk of the gonopods and the complexity of the terminal portion of the telopodite of the gonopods. These characters are shown below to be ineffective as distinguishing characters on the generic level. The reduction of the two names *Tucoria* and *Anfractogon* to synonyms of *Brachoria* allows use of the cingulum as the single most important diagnostic character of the genus.

No other taxonomic character has yet been found which will effectively distinguish *Brachoria* from other closely related genera. One character is sometimes useful in this regard, however. This is the shape of the paranota, which in many species of *Brachoria* are gently rounded forward at the caudolateral corners. Some species, however, have the caudolateral corners of the paranota produced caudad. All known species of the related genera *Apheloria* and *Sigmoria* show this caudad projection of the paranota to at least a small extent. Although it is possible to distinguish species with rounded paranota as belonging to the genus *Brachoria* without resort to the male gonopods, species with the caudolateral corners of the paranota produced caudad may or may not belong to this genus. For purposes of comparisons, the ninth segment is used in describing this feature. At mid-body level, variations in this character are very slight. Variations in the shapes of the paranota of the last three or four segments are very difficult to compare and are of little taxonomic value.

The paranotal swellings are usually weakly developed in species of *Brachoria* but it is difficult to use this character accurately as the differences are very slight.

It is indeed unfortunate that so far no good character other than the structure of the male gonopods has been found to be diagnostic of the genus. The cyphopods are apparently the same for all species. This, of course, leaves the identification of females a very difficult, if

not impossible, undertaking. Females with rounded paranota may be identified as *Brachoria* with some degree of assurance. Females of species which do not show this character cannot be identified even to genus unless they are found with the males or unless they are gravid and males can be reared from the eggs which they produce. All females treated in this paper were found with males and identified on that basis.

On the specific and subspecific levels, the male gonopods once again provide the best taxonomic characters. Their shape, relative bulk, and complexity form reliable criteria for separation of the various forms. The major features of the telopodite portion show little variation and the experienced worker can easily predict the extent of this individual variation even if only a few specimens are at hand.

The size of the gonopods has been found to be fairly consistent at the species level except in the case of *separanda* where the great variation may be correlated with geographical distribution. The size of the gonopods is indicated in the descriptions by two measurements, the telopodite arc length and the telopodite arc width. The first of these measurements is made in a plane perpendicular to the telopodite base line and is the distance from the base of the telopodite to the most distant point on the arc measured in a straight line. The arc width is measured in a plane perpendicular to the plane of the preceding measurement and is the greatest outside diameter of the arc. For further explanation of these measurements see the drawings of the gonopod of *initialis* in figure 1a.

One gonopod character which has been found to vary somewhat extensively, however, is the size of the prefemoral spine (compare figs. 3a, 3g). Though in some species this is apparently a rather stable character, in others it varies considerably. If the spine is not only long but of a rather heavy and sturdy form, it usually does not show much variation. If it is very slender in form even if sometimes quite long, it will apparently exhibit much individual variation. *Brachoria insolita* is a species that shows much variation in this character (see fig. 6e).

The shape of the collum varies somewhat from species to species, but the differences are so slight they are very difficult to use as taxonomic characters. The development of the paranotal swellings on the collum and of the ridges running from them along the cephalic edges of the paranota are of considerable use as specific characters. They show slight individual variation.

The extent of development of the coxal armature has in the past been considered of some value. This has been found to be quite a variable character, however, and would seem to be of little value except, perhaps, as an aid in separating two species where the typical

sizes of armature lie at the two extremes. Females always show stronger armature than males.

The extent of development of sternal processes between the 3d–6th pairs of legs has been mentioned commonly in the past. The present study has indicated that these structures are not reliable as taxonomic characters inasmuch as they often vary all the way from total absence to strong development in specimens of the same species collected at the same locality. Females do not show these sternal characters at all. Variations in the postgenital sternites are of no taxonomic value.

The shape of the preanal scale shows great individual variation but no consistency of taxonomic value.

Both the body length and body width have also been found to vary greatly and hence their use as taxonomic characters is difficult. Females are always larger than males.

Color has often been used in the past as a specific level character in the Xystodesmidae. Hoffman (1950, 1951), however, has found that color is often at best only a subspecific character in this family. This study tends to confirm his findings (see *Brachoria calcaria*, new species, p. 15).

NOTES ON SYNONYMY: Chamberlin (1943) established *Tucoria* as a new genus to include the two species described by Causey (1942) as *Fontaria kentuckiana* and *Cleptoria splendida*. Although in both of these species a cingulum divides the telopodite of the male gonopods into two portions just as in *Brachoria*, Chamberlin believed them to be generically distinct because of the noticeably heavier bulk and greater complexity of the terminal portion of the telopodite. The three other species subsequently described in this genus—*T. dynama* Chamberlin, *T. viridicolens* Hoffman, and *T. calceata* Causey—show this same type of form. All the “*Tucoria*” species are obviously fairly closely related to each other. The genus has been known only from the State of Kentucky.

Hoffman (1948b) published a key to the species of *Tucoria* in which he used the form of the prefemoral spine. Causey (1955) later claimed that this character is the most diagnostic one for the genus. She stated that the spine is always “well-developed, cylindrical, and acute” in *Brachoria* while it is variable in *Tucoria*, being “either almost absent, peglike, or triangular.”

The new forms described in the present paper provide evidence that neither of the above characters will hold for genera. The new species *Brachoria hoffmani* and *B. laminata* from southwestern Virginia, though not closely resembling any of the previously known forms of *Tucoria*, might on the basis of the bulk of their gonopods be put into that genus. The new species *Brachoria turneri*, however, presents more of a problem. The form of its gonopods is much more like

that of the average *Brachoria* but the bulk is considerably greater than is usual in that genus. If *turneri*, which is somewhat intermediate in bulk, is in *Tucoria*, the question of the new species *ligula* and *hubrichti* immediately arises. The bulk of their gonopods is not much less than *turneri* yet they closely approach the relative bulk of such *Brachoria* species as *ochra*, *electa*, and *glendalea*. Thus it becomes obvious that this character is not effective in separating *Tucoria* and *Brachoria* inasmuch as the presently known species form such a continuum that it is impossible to say where dividing lines should be.

In the case of the prefemoral spine as a generic character, attention is called to the two new species *Brachoria hoffmani* and *B. laminata*. Though these are *Tucoria*-like in bulk, they both show very strong development of cylindrical, acute, prefemoral spines. Thus, using Causey's criterion, they would be assigned to *Brachoria*. At the other extreme, however, a specimen of *eutypa* from North Carolina, though typical of *Brachoria* in bulk, shows practically no development of the prefemoral spine. It would, as a result, be placed in *Tucoria* if the spine were used as a generic character. The new species *Brachoria dentata* is also more like the typical *Brachoria* than *Tucoria* in all respects except the spine which is nearly absent. The final and strongest argument is, however, the fact that this character has been found to exhibit considerable individual variation. The case of *B. eutypa* mentioned above is an example. Most specimens of this subspecies have well-developed spines while the single North Carolina specimen does not. Likewise study of a series of specimens of the new species *insolita* shows variation in the spine from near nonexistence to moderate development. Thus this character cannot be used to separate *Tucoria* and *Brachoria*.

Careful study has not revealed even a single character that will make possible a consistent and meaningful separation of *Tucoria* from *Brachoria*. It is, therefore, my opinion that *Tucoria* must fall as a synonym of *Brachoria*.

The genus *Anfractogon* was described by Hoffman (1948a) to include the species *tenebrans* from Alabama. Hoffman stipulated three characters as diagnostic of the genus. The first was the processes on the sternites of the third, fourth, and fifth legs of the male. This study has shown that processes are always present in *Brachoria* on the sternites of the third and fourth legs and that those on the sternite of the fifth legs are quite variable.

The second character mentioned by Hoffman was the form of the prefemoral spine. This has already been shown in the discussion of *Tucoria* to be a variable character and of no value on the generic level.

The third character was the much-modified distal end of the male gonopod. The species recently described by Causey as *Brachoria*

electa shows some modification of this type, although in all other respects it so closely resembles the type species *Brachoria initialis* that it may in the future have to be reduced to a subspecies of *ochra*. The new species *B. hoffmani* shows modification similar in some respects to *Anfractogon tenebrans*. Furthermore, a specimen of *tenebrans* from northern Alabama does not exhibit as much modification as does the type specimen of the species and appears in every way typical of the genus *Brachoria*.

Inasmuch as no character has been found by which *Anfractogon* may be separated from *Brachoria*, it is my opinion that *Anfractogon* must fall as a synonym of *Brachoria*.

DIAGNOSIS: A xystodesmid genus with telopodite of male gonopod bisected by a cingulum dividing it into proximal setose region and distal glabrous region. Telopodite forming arc variable in both size and complexity. Gonopod aperture subovoid, cephalic side slightly indented.

Body broad, length 3.5–4.9 times the width; length 30–52 mm.; width 6.5–12.5 mm. Paranota wide, usually overlapping, those of ninth segment often with caudolateral corners not produced caudad or if produced, usually only slightly so. Paranotal swellings usually not strongly developed, often almost lacking on collum and on 2d segment. Repugnatorial pores distributed in normal manner for the family, opening dorsally in paranotal swellings. Antennal sensory cones, 4.

RANGE: Southeastern United States: Alabama and Mississippi north to southern Indiana, West Virginia, and extreme western Maryland, and east to southwestern Virginia and western North Carolina.

SPECIES: 25, two of which have an additional subspecies.

Key to known species and subspecies of *Brachoria*

1. Precingular portion of telopodite of male gonopod much shorter than postcingular portion 2
Precingular portion subequal or longer than postcingular portion . . . 3
2. A tooth present on the anterior side of the postcingular portion of the telopodite (fig. 2e) **dentata**, new species (p. 18)
A tooth present on the posterior side of the postcingular portion of the telopodite (fig. 6d) **insolita**, new species (p. 36)
3. One or more spines on the cephalic side of the precingular portion of the telopodite (fig. 1d,g) **calcaria**, new species (p. 15)
No spines on the precingular portion of the telopodite 4
4. Solenomerite large and conspicuously pectinate (fig. 6i).
kentuckiana (Causey) (p. 38)
Solenomerite small or not pectinate, or no solenomerite present 5
5. Postcingular portion of telopodite with four sharp spines on outer surface (fig. 9h) **viridicolens** (Hoffman) (p. 50)
No spines on outer surface of telopodite 6

6. A large, rather thin terminal plate on distal end of telopodite 7
No such thin terminal plate present 8
7. Terminal plate longer than broad, its distal portion strongly curved (fig. 5*d-f*) **hoffmani**, new species (p. 31)
Terminal plate about as broad as long, its distal portion not curved (fig. 7*a*).
laminata, new species (p. 39)
8. Telopodite very simple and slender, forming a large, continuous arc with no abrupt bends, the distal end acuminate (fig. 5*a*) . **hansonia** Causey (p. 31)
Telopodite of gonopod not as described 9
9. Telopodite noticeably swollen just beyond the egingulum, abruptly narrowing again more distally 10
Telopodite not noticeably swollen just beyond the egingulum, or if so, not becoming abruptly slender more distally 11
10. Distal portion of telopodite twisted (fig. 8*b*) . . **plecta**, new species (p. 43)
Distal portion of telopodite not twisted, simple, the end acuminate (fig. 8*h*).
separanda Chamberlin (p. 44)
11. Pronounced ridges present along cephalic margins of paranota of collum . 12
Ridges absent or very weak 23
12. Posteingular portion of telopodite of gonopod bent cephalically at a right angle when viewed mesially (fig. 1*l*) **calceata** (Causey) (p. 16)
Posteingular portion of telopodite not so shaped 13
13. Telopodite small, slender, forming a simple arc, but with a sharp bend in the posteingular portion; the distal portion not curving back close to the preeingular shaft 14
Gonopod not as described 16
14. The bend not extremely sharp, the telopodite narrowing very abruptly beyond the bend thereby forming a pronounced shoulder at the bend; the distal portion of the telopodite dagger-like with a very acute point (fig. 2*a-c*) **cedra**, new species (p. 17)
The bend very sharp; the telopodite not narrowing so abruptly nor forming such a noticeable shoulder, the distal portion not dagger-like (fig. 1*a-c*) 15
15. Distal end of telopodite acuminate (fig. 1*a*) . **ochra initialis** Chamberlin (p. 11)
Distal end of telopodite more blunt . . **ochra ochra** (Chamberlin) (p. 10)
16. Posteingular portion of telopodite with a very pronounced caudally directed twist about midway of its length (fig. 2*g,h*) . . . **electa** Causey (p. 20)
Telopodite with no such twist 17
17. Entire telopodite are completed quite distant from telopodite base; posteingular portion of telopodite relatively broad, thin, and flat, with no hook in the distal portion and no distinct solenomerite (fig. 4*d-f*).
glendalca (Chamberlin) (p. 28)
Gonopod not as described 18
18. Distal end of telopodite with a distinct solenomerite set off from main portion of telopodite 19
No distinct solenomerite 20
19. Telopodite rather flat and moderately broad, forming a continuous arc, the solenomerite tongue-like in shape (fig. 7*d*) . . **ligula**, new species (p. 40)
Telopodite very bulky, with a strong ridge along cephalic side of distal half of posteingular portion (fig. 8*d*) **splendida** (Causey) (p. 47)
20. Gonopod small, less than 1.7 mm. in telopodite are length and 1.2 mm. in telopodite are width; the arc rather slender and simple with no hook in the distal portion (fig. 6*a-c*). **indianae** (Bollman) (p. 34)
Gonopod larger, more than 1.8 mm. in telopodite are length and 1.3 mm. in telopodite are width; the arc either not so slender or with a hook in the distal portion 21

21. Telopodite simple, with no hook in the distal portion, the end blunt (fig. 5g).
hubrichti, new species (p. 33)
A hook in the distal portion of the telopodite 22
22. The hook elaborate, involving more than just the extreme distal end of the
telopodite (fig. 9c,d) **tenebrans** (Hoffman) (p. 48)
The hook not elaborate, being only slightly bent, involving only the extreme
end of the telopodite (fig. 3a,e) . . . **cutypa cutypa** Chamberlin (p. 21)
23. Distal portion of posteingular part of telopodite are curving in a plane
subparallel to the body, never curving back dorsally towards the body;
prefemoral spine very large (fig. 7g,h) . . . **mendota**, new species (p. 42)
Distal portion of telopodite curving back dorsally towards the body . . . 24
24. Posteingular portion of telopodite very thin and weak, the distal part
flattened into a sickle-shaped blade (fig. 4a-c) . . **falcifera**, new species (p. 27)
Gonopod not as described 25
25. Telopodite heavy and broad, for most of its length (fig. 9e).
turneri, new species (p. 49)
Telopodite not heavy and broad 26
26. A strongly developed hook in the distal end of the telopodite, the portion
forming the hook much reduced in size from the portion just proximal to
the hook (fig. 4g) **hamata**, new species (p. 30)
Extreme distal portion of telopodite somewhat hooked but the portion form-
ing the hook not much, if any, reduced in size from the portion proximal
to the hook 27
27. A swelling present on the telopodite just proximal to the hook (fig. 3h,j).
cutypa ethotela Chamberlin (p. 23)
No such swelling present (fig. 3f) . . **cutypa cutypa** Chamberlin (p. 21)

Brachoria ochra ochra (Chamberlin)

Fontaria ochra Chamberlin, Psyche, vol. 25, pp. 123-124, 1918.

Brachoria sequens Chamberlin, Bull. Univ. Utah, biol. ser., vol. 5, No. 3, p. 4,
fig. 2, 1939. New synonymy.

Brachoria ochra, Chamberlin and Hoffman, U. S. Nat. Mus. Bull. 212, p. 25,
1958.

ORIGINAL DESCRIPTION:

The types are in general fulvous, with the legs and antennae yellow, in most somewhat darker across the anterior region of the somites, though in the darkest individual of all the darkest part of the somite is in a narrow stripe slightly in front of the caudal margin. The general color appearance is much like that of *F. crassicutis* Wood. The carinae in some are somewhat paler than the intervening region.

Body obviously narrowed at both ends, the sides over most of the length being parallel or nearly so. Lateral carinae moderately large, not raised at angle to general slope of somites excepting in caudal region. Posterior margin of carinae in anterior region straight, slightly bent caudad in middle region, more so in posterior region, but only the last few acutely angularly produced.

Vertigial sulcus distinct, ending abruptly at or a little above upper level of antennal sockets. Occipital foveolae 2+2.

In the male the sternites and the coxae are without special processes.

In the gonopods of the male the principal or distal division is stout at the base and narrows gradually distad; it extends ventrad and then curves across to the other gonopod and then coils dorsad; near the point where it begins the bend dorsad it is somewhat geniculate, the portion beyond the geniculation being more slender and somewhat doubly or sigmoidally curved with the acute tip bent

mesad almost at right angles; it is densely pilose at base on the mesal side and less strongly so along the edge to near the level where the bend across to the other side begins. The basal process is short, straight and acute and extends obliquely caudomesoventrad to near the tip of the principal process of the opposite gonopod.

Length of type (male) about 35 mm.; width, 10 mm.

Locality: Mississippi: Agricultural College. Six specimens collected in the fall of 1916 by J. W. Bailey.

Since I have not personally examined a specimen of *B. ochra ochra* and thus am unsure of the details of many characters, no new description of this subspecies is given in the present paper. Chamberlin's original description is quoted above in its entirety.

TYPE SPECIMEN: Male holotype in the private collection of R. V. Chamberlin. Female and immature paratypes in the Museum of Comparative Zoology.

TYPE SPECIMEN OF SYNONYM: Type of *Brachoria sequens* in the private collection of R. V. Chamberlin.

***Brachoria ochra initialis* Chamberlin, new combination**

FIGURE 1a-c

Brachoria initialis Chamberlin, Bull. Univ. Utah, biol. ser., vol. 5, No. 3, pp. 3-4, fig. 3, 1939.

Brachoria brachypus Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, pp. 26-28, fig. 9, 1947. New synonymy.

Brachoria benderi Causey, Ent. News, vol. 61, pp. 193-195, figs. 1, 2, 1950. New synonymy.

DIAGNOSIS: Distinguished from all other species of the genus except *electa*, *indianae*, *cedra*, and *separanda* by the small size and bulk and simple form of the male gonopods. Differs from *electa* in lacking a caudally directed twist in the terminal portion of the telopodite, and from *indianae*, *cedra*, and *separanda* in the exceedingly sharp nature of the bend forming a ridge in the postcingular portion of the telopodite. Differs from *ochra ochra* in the subacuminate distal end of the telopodite.

DESCRIPTION: Length of holotype, 37 mm.; width, 10.2 mm.; length of other specimens, 30-38 mm.; width, 7-12 mm.

Tergites somewhat flattened, paranota wide, continuing slope of dorsum; very finely coriaceous; prozonites smooth. Body gently tapering caudad from midbody region to segment 18, then much more abruptly to end of telson.

Collum subellipsoidal, posterior edges of paranota directed slightly cephalad from their bases, margins only faintly curved; ends of paranota very narrowly rounded, caudolateral corners of paranota rather sharp; paranotal swellings weakly evident, pronounced ridges extending from them along cephalic margins of paranota to points slightly above anterior bases of paranota.

Tergites of segments 2 and 3 not of full width or length. Caudolateral corners of paranota rather sharply rounded. Paranotal swellings present.

Tergite of segment 4 of normal width but slightly shorter than succeeding ones. Paranota and paranotal swellings like those of segments 2 and 3.

Tergites of segments 5-16 similar to each other in both length and width. Caudolateral corners of paranota becoming increasingly produced caudad, this condition marked at level of 9th segment. Posterior edges of paranota of segment 13 and all succeeding segments noticeably directed caudad. Paranotal swellings strong.

Paranota of segments 17 and 18 rather sharply triangular. Paranotal swellings very strong.

Anal segment subtriangular in dorsal aspect, apex truncate; two small subterminal lateral tubercles present.

Anal valves inflated, unsculptured, with prominent mesial ridges; the usual setiferous tubercles present.

Preanal scale variable in shape, sometimes subtriangular with the two lateral tubercles well below level of terminal protuberance and base of scale almost straight, sometimes subellipsoidal with the two lateral tubercles on nearly same level as terminal protuberance and base of scale strongly curved.

Vertigial sulcus of head distinct, ending little above upper level of antennal sockets. Occipital foveolae 2+2, moderately distinct; antennal foveolae 1+1, very indistinct; clypeal foveolae 1+1, very distinct. Antennal article 2 the longest, 3-6 subequal; articles 1-4 only sparsely hirsute, 5-6 heavily hirsute; antennal sensory cones 4. Mouthparts typical of the family Xystodesmidae.

Sternum of 3d pair of legs with prominent pair of somewhat fused processes; sterna of 4th and 5th legs each with a pair of small, separate processes; sternum of 6th legs smooth.

Second pair of legs with usually cylindrical, distally truncate, seminal lobes. Pregenital limbs heavily hirsute, without spines on prefemora.

Coxae and prefemora of postgenital legs small, their combined length subequal to that of 3d podomere; 4th and 5th podomeres shorter than 3d, subequal; 6th podomere slightly longer than 4th and 5th. Strong, gently curved claws present. Prefemora of postgenital legs heavily armed. Coxal armature weak to moderate.

Gonopod aperture ovoid, cephalic side slightly indented, caudal margin with prominent flange. Male gonopods small (about 1.58-1.74 mm. in telopodite arc length and 0.90-1.04 mm. in arc width); simple in form; curved mesiad, distal end bent very sharply dorsad; tip

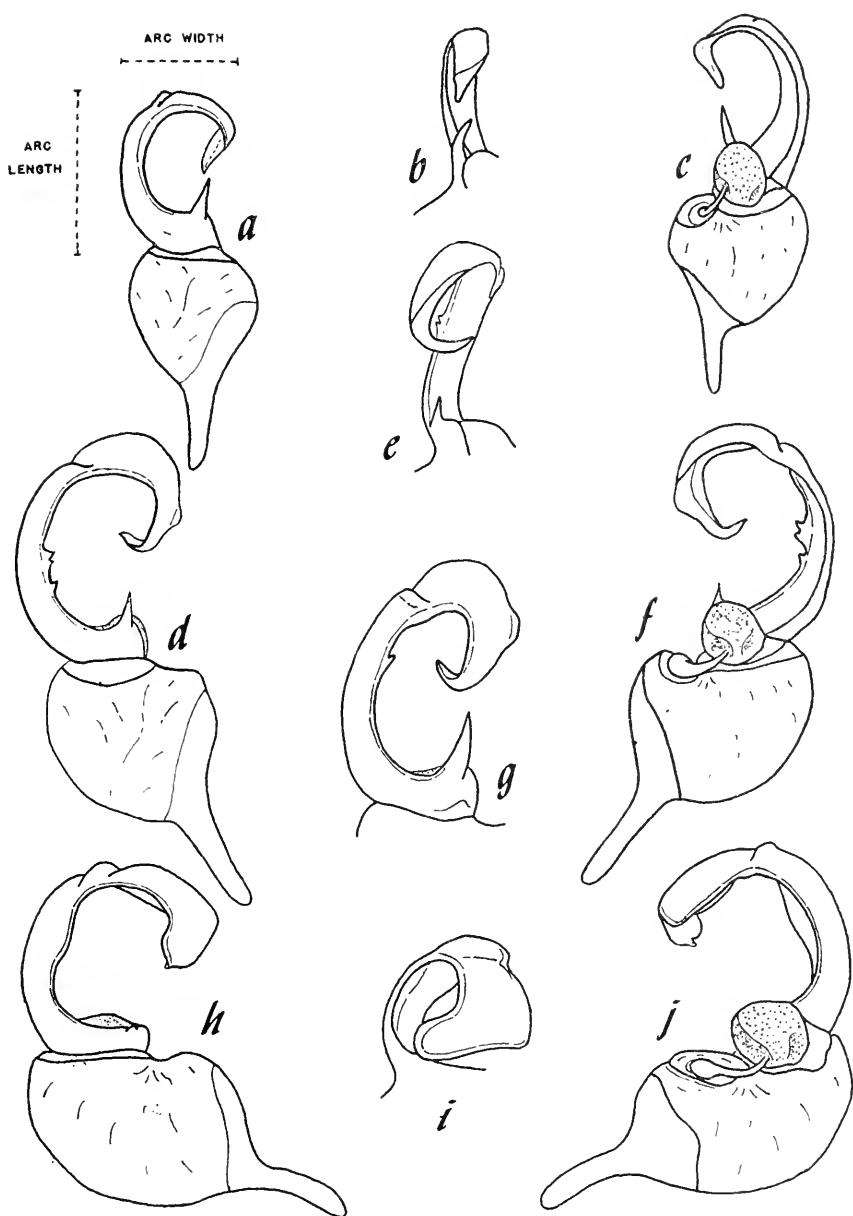


FIGURE 1.—Left male gonopods of species of *Brachoria*. *a-c*, *B. ochra initialis*: cephalic, mesial, and caudal views. *d-g*, *B. calcaria*: *d-f*, cephalic, mesial, and caudal views of holotype; *g*, cephalic view of specimen from near Hinton, W. Va., showing larger gonopod with only one spine. *h-j*, *B. calceata*: cephalic, mesial, and caudal views.

subacuminate; cingulum located at point of strongest mesial curvature; precingular portion of telopodite longer than postcingular portion. Prefemoral spine moderately strong.

Cyphopods large, their aperture bordered caudally by weak marginal lip; receptacle large and strong; both valves with small median dorsal concavity; valves subequal in length.

Color faded in all specimens examined by the author. Causey's description of *benderi* indicates color was dark brown with bright pink on paranota.

TYPE LOCALITY: Maplesville, Chilton County, Ala.

TYPE SPECIMEN: Private collection of R. V. Chamberlin.

TYPE SPECIMENS OF SYNONYMS: Types of *Brachoria brachypus* and *Brachoria benderi* in the Academy of Natural Sciences of Philadelphia.

PUBLISHED DISTRIBUTION RECORDS:

MISSISSIPPI: Rankin County: Piney Woods (type locality of *benderi*). TENNESSEE: Roan County: Harriman (type locality of *brachypus*).

NEW DISTRIBUTION RECORDS:

ALABAMA: Lauderdale County: 8½ miles northeast of Florence, Dec. 12, 1937 (1 ♂), J. P. E. Morrison. Lee County: Chewacla State Park, May 6, 1954 (1 ♂, 1 ♀), Hubricht. Tuscaloosa County: Tuscaloosa, Mar. 29, 1948 (1 ♂), George Ball. TENNESSEE: Anderson County: Clinch River bluff, 4 miles southwest of Clinton, May 10, 1951 (1 ♂), Hubricht.

DISCUSSION: Inasmuch as only female and immature paratypes are present in the Museum of Comparative Zoology, and no drawings were included in the original description, the identity of *ochra* has long been in doubt. Personal communications with Dr. Chamberlin now make it possible to clear up the matter. A sketch of the gonopods of *ochra* made by Chamberlin resembles exactly the drawing of *Brachoria sequens* published by Chamberlin in 1939. Thus *sequens* must be considered a junior synonym of *ochra*. The two were described from the same type locality—Agricultural College, Oktibbeha County, Miss.

At my request, Chamberlin kindly compared a specimen of *B. benderi* Causey (= *B. initialis* Chamberlin) with his specimens of *B. ochra* and found that they were very similar. The only difference that he found was in the terminal portion of the male gonopods. In *benderi* the terminal division is smaller, with the apical portion straight and acute, while in *ochra* it is longer, more lamellate, bent at the distal end into a somewhat spoon-like shape, and not so acute. Chamberlin suggested that this difference might be varietal only. Careful examination of all available specimens has convinced me that this is actually the case and that the two forms are at best only subspecifically distinct.

A specimen from near Tuscaloosa, Ala., was sent to Chamberlin who compared it with the holotype of *B. initialis*. He found the two to be

identical. This metatype specimen of *initialis* has been used in my decisions concerning synonymy and is also the basis for the description of the form given above.

Careful comparison of the metatype of *B. initialis* with the holotypes of *B. benderi* Causey and *B. brachypus* Chamberlin has shown that the three are conspecific and do not exhibit sufficient differences to warrant even subspecific designations. Thus both *benderi* and *brachypus* must be submerged as synonyms of *B. initialis*, which must in turn now be designated as *Brachoria ochra initialis*.

In the original descriptions of both *sequens* and *brachypus*, Chamberlin mentioned the presence of a second joint in the telopodite of the male gonopod. Examination of many specimens, including the holotype of *brachypus*, has convinced me that there is only one true "joint" or cingulum present, the more distal structure being actually only a very sharp and abrupt bend in the telopodite.

It is interesting to note that the range of *B. ochra initialis*, as now conceived, is by far the largest one known for any form of *Brachoria*. Specimens are known from four widely separated locations in Alabama, from one locality in Mississippi, and from two locations in Tennessee.

Specimens of *B. ochra initialis* vary considerably in body size. This variation is apparently not correlated with geographical distribution. It is exceedingly interesting to note that, regardless of body size, the size of the gonopods varies only slightly.

Brachoria calcaria, new species

FIGURE 1d-g

DIAGNOSIS: Distinguished from all other species of the genus by the presence of one or more spines on the precingular portion of the telopodite of the male gonopod. Shows a banded color pattern while the closely related species *B. separanda* usually shows a trimaculate pattern.

DESCRIPTION: Length of male holotype, 38 mm.; width, 10 mm.; length of other males, 38-43 mm.; width, 9-10.5 mm.; length of female, 49 mm.; width, 10 mm.

Collum with ends rounded; paranotal swellings and ridges absent.

Paranotal swellings absent on 2d segment, weakly present on 3d segment, moderate on 4th and all succeeding segments. Paranota of segment 2 and all succeeding midbody segments rounded.

Sternum of 4th pair of legs with pair of weak processes; sternum of 5th legs with pair of very small mounds; sternum of 6th legs with transverse ridge.

Coxal armature moderate to strong.

Male gonopods of medium size (about 2.0 mm. in telopodite arc length and 1.7 mm. in arc width); curving mesiad, then dorsad, then caudolaterad, all in relatively smooth curves; portion of telopodite

just distal to cingulum distinctly swollen; a small, thin flange present on caudomesial surface of postcingular portion of telopodite at about midpoint of its length (this flange not present in the closely related species *separanda*); extreme distal portion of telopodite tapering to acute point. Variable number (usually 1-4) of small spines present on precingular portion of telopodite at about midpoint of its length; size of spines variable. Prefemoral spine moderate.

Color variable; very dark brown above with entire caudal edge of tergites brightly colored, these bands sometimes bright red (Riner specimens and some Blacksburg specimens, including the holotype), sometimes bright lemon yellow (West Virginia specimens), and sometimes red on paranota and yellow on dorsum or red on anterior segments and yellow on posterior 3 or 4 segments including the telson (some Blacksburg specimens); a light median spot on cephalic edge of collum; underparts straw-colored.

TYPE LOCALITY: Blacksburg, Montgomery County, Va.

TYPE SPECIMENS: Male holotype collected by W. C. Lund, June 26, 1956. Male and female paratypes collected by L. T. Richardson, June 26, 1956, at Riner, Montgomery County, Va. All type material is in the U. S. National Museum.

OTHER DISTRIBUTION RECORDS:

WEST VIRGINIA: Summers County: about 10 miles southeast of Hinton on Route 12, July 16, 1956 (2 ♂, 1 ♀), Hoffman. VIRGINIA: Montgomery County: Blacksburg, Dec. 9, 1956 (2 ♂), Hoffman. Three males with no collection labels found in the collections of the Biology Department of Radford College; the evidence seems to indicate that they were collected near Radford, Va., in the early part of this century.

DISCUSSION: *Brachoria calcaria* resembles *B. separanda* in the general form and shape of the male gonopods, and I at first considered describing it as a subspecies of the latter species. Further study indicated that this was not advisable, however, inasmuch as there appears to be no evidence of intergradation of the distinguishing characters. The known ranges of the two species are not far distant from one another yet all specimens are fully distinct.

The enormous variation in color in this species is of special interest. It serves to call attention to the very close relationship of red and yellow pigments in many millipeds.

Brachoria calceata (Causey), new combination

FIGURE 1h-j

Tucoria calceata Causey, Proc. Biol. Soc. Washington, vol. 68, p. 28, figs. 4, 5, 1955.

DIAGNOSIS: Distinguished from all other species of the genus except *tenebrans* by the prominent right angle bend in mesial view of the postcingular portion of the telopodite of the male gonopod, the distal por-

tion of which is not thin or plate-like. Differs from *tenebrans* in lacking the hook-shaped distal end of the telopodite.

DESCRIPTION: Length of male holotype, unknown; width, 10 mm.

Collum subellipsoidal, edges gently curved, ends of paranota narrowly rounded; paranotal swellings absent; moderately strong ridges along cephalic margins of paranota.

Paranotal swellings absent from segment 2, weakly present on segments 3 and 4, rather strong on segment 5 and all succeeding segments. Paranota of segments 2-4 rounded, those of segment 5 and all succeeding midbody segments rather square in shape; paranota of posterior segments bluntly triangular, the apexes rounded.

Sternum of 3d pair of legs with the usual processes; sternum of 4th legs with a pair of weak processes; sternum of 5th legs with a pair of small rounded mounds; sternum of 6th legs with no processes.

Coxal armature weak to moderate.

Male gonopods of medium size (about 1.85 mm. in telopodite arc length and 1.8 mm. in arc width); curved cephalomesiad, then cephalodorsad, then laterad; postcingular portion of telopodite short, heavy, boot-shaped, with small terminal solenomerite; precingular portion longer than postcingular portion. Prefemoral spine reduced to a very small nub.

Color completely faded.

TYPE LOCALITY: Tyrone, Anderson County, Ky. Known only from the type locality.

TYPE SPECIMEN: In American Museum of Natural History.

Brachoria cedra, new species

FIGURE 2a-c

DIAGNOSIS: Distinguished from all other species of the genus except *ochra*, *electa*, *separanda*, and *indianae* by the small size and simple form of the male gonopods. Differs from those species in the abrupt narrowing of the distal part of the postcingular portion of the telopodite of the gonopod.

DESCRIPTION: Length of male holotype, 36.5 mm.; width, 10 mm.

Collum subellipsoidal, ends of paranota moderately rounded; paranotal swellings very weak; ridges present along cephalic edges of paranota.

Paranotal swellings very weak on segment 2, slightly stronger on segments 3-5, moderately strong on segment 6 and all succeeding segments. Paranota of segment 2 and all succeeding segments square.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with a pair of small but quite evident processes; sternum of 5th legs with a pair of low mounds; sternum of 6th legs smooth.

Coxal armature weak.

Male gonopods rather small (about 1.78 mm. in telopodite arc length and 1.20 mm. in arc width); simple in form; curving mesiad, then rather abruptly dorsad; telopodite narrowing abruptly at latter bend forming slender solenomerite which comes to acute point; prominent shoulder on caudal side of telopodite at point of abrupt narrowing; precingular portion of telopodite longer than postcingular portion. Prefemoral spine moderate.

Color faded, indicates a possible trimaculate pattern.

TYPE LOCALITY: Cedar glades near Jonesville, Lee County, Va. Known only from the type locality.

TYPE SPECIMEN: Collected by Loyd Carr, May 1955. Male holotype deposited in the U. S. National Museum.

DISCUSSION: The resemblances between this species and *B. ochra* are very marked and this form may eventually be shown to be only subspecifically distinct from *B. ochra*. For the present, however, it seems best to treat the two separately inasmuch as the differences are easily seen and the variation shown by *B. ochra* throughout its unusually large range is so slight as to make one wonder if it might not eventually be found in its typical form in the area of southwestern Virginia where *B. cedra* is known to occur.

Brachoria dentata, new species

FIGURE 2d-f

DIAGNOSIS: Distinguished from all other species of the genus except *insolita* by the position of the cingulum on the telopodite of the male gonopod and by the tooth on the postcingular portion. Differs from *insolita* in that the tooth is on the cephalic side of the telopodite in this species while it is on the caudal side in *insolita*. The distal portion of the telopodite of *dentata* does not bend sharply cephalad as does that of *insolita*.

DESCRIPTION: Length 40 mm.; width 11 mm.

Collum ellipsoidal; posterior edges of paranota curving gently cephalad from their bases; ends of paranota not so narrowly rounded; paranotal swellings not noticeable; pronounced ridges extending from ends of paranota along their cephalic margins to points at anterior bases of paranota.

Caudolateral corners of paranota of 2d and all succeeding segments becoming increasingly squared; those of 9th segment quite square. Paranotal swellings almost lacking on second segment; only weakly present on succeeding segments.

Processes on sterna of 3d, 4th, and 5th pairs of legs prominent; sternum of 6th legs smooth.

Coxal armature moderate.

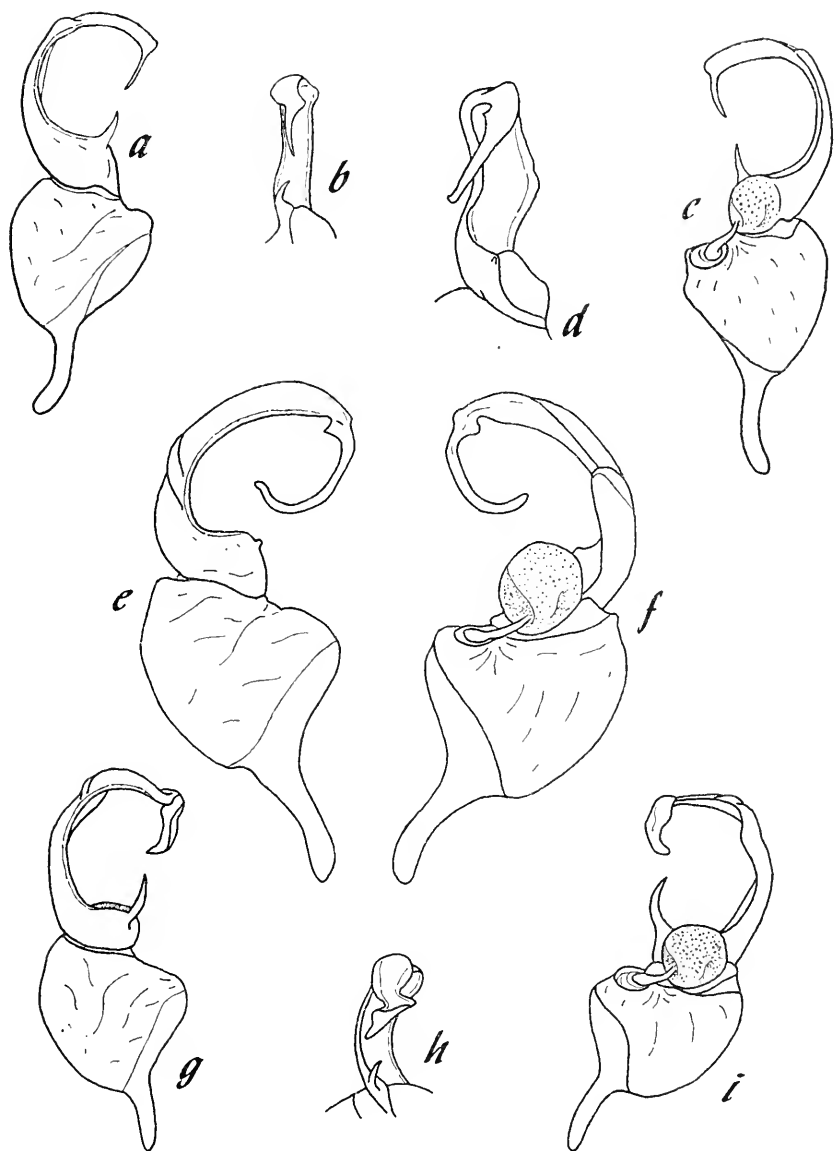


FIGURE 2.—Left male gonopods of species of *Brachoria*. *a-c*, *B. cedra*: cephalic, mesial, and caudal views. *d-f*, *B. dentata*: mesial, cephalic, and caudal views. *g-i*, *B. electa*: cephalic, mesial, and caudal views.

Gonopods of medium size (about 2.08 mm. in telopodite arc length and 1.86 mm. in arc width), curved cephalomesiad at cingulum, then dorsad, then caudolaterad, then ventrad at tip; a strong tooth on cephalic side of postcingular portion of telopodite about midway of its length; tip subacuminate; cingulum located low on telopodite, precingular portion or telopodite much shorter than postcingular portion.

Color faded in specimens examined.

TYPE LOCALITY: Cumberland Mountains, Pennington Gap, Lee County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by H. G. Hubbard. No date given. Male holotype and male paratype in the U. S. National Museum.

DISCUSSION: *Brachoria dentata* is strikingly different from any of the species of the genus heretofore known. The cingulum of the gonopod is located low on the telopodite so that the precingular portion is much shorter than the postcingular portion. *Brachoria insolita* is the only other species of the genus that shows this characteristic. The presence of a well-defined tooth on the telopodite well back from the end is also a character found elsewhere in this genus only in *Brachoria insolita*. The two species resemble each other also in the prefemoral spine which is apparently either almost absent or rather weak.

It seems apparent on the basis of the characters mentioned that *dentata* and *insolita* are more closely related to each other than to any other species of the genus. Indeed, a case could be built for erecting a new genus to include them, but it seems wiser at present to retain them in *Brachoria*. Knowledge of the various genera of the Xystodesmidae is still very meager and the strong probability of future discovery of new and annectant forms makes a somewhat conservative course concerning genera the most advantageous. The cases of *Tucoria* and *Anfractogon* provide good examples illustrating the basis for this line of reasoning.

Brachoria electa Causey

FIGURE 2g-i

Brachoria electa Causey, Proc. Biol. Soc. Washington, vol. 68, pp. 25, 27, fig. 3, 1955.

DIAGNOSIS: Distinguished from all other species of the genus except *ochra*, *indiana*, *cedra*, and *separanda* by the small size and bulk of the gonopods and by their simple form. Differs from the four species mentioned in having a caudally directed twist in the distal portion of the telopodite.

DESCRIPTION: Length of holotype, not given; width, 9.6 mm.; length of other male specimens, 36-38 mm.; width 9 mm.; length of female, 41 mm.; width, 9 mm.

Resembles *B. ochra initialis* in all but the characteristics mentioned below.

Ends of paranota of collum not as narrowly rounded; paranotal swellings very weak; ridges on anterior edges of paranota not so strongly developed.

Paranota of 2d and all succeeding segments more rounded; caudolateral corners of 9th paranota only very slightly produced caudad or not at all; paranota of segments 17 and 18 not so sharply triangular.

Sternum between 4th legs with pair of small but distinct processes; sternum of 5th legs with pair of weak, indistinct processes; sternum of 6th legs with no processes.

Coxal armature well developed.

Gonopods small (about 1.74 mm. in telopodite arc length and 1.19 mm. in arc width); curved mesiad, then twisted abruptly caudad, then curving dorsad, tip subacuminate; cingulum located at point of strongest mesial curvature; precingular portion somewhat longer than postcingular portion. Preformal spine moderately strong. Cyphopods like those of *initialis*.

Color faded in all specimens but some evidence that pattern was either of trimaculate type or banded type.

TYPE LOCALITY: Tyrone, Anderson County, Ky.

TYPE SPECIMEN: In American Museum of Natural History.

NEW DISTRIBUTION RECORD:

KENTUCKY: Mercer County: Kentucky River bluff, 1 mile northeast of Shaker-town, May 1, 1954 (1 ♂, 1 ♀), Hubricht.

DISCUSSION: This species resembles very closely *Brachoria ochra initialis*, the type of the genus. The two forms agree closely in general body form, differing only in the extent to which the caudolateral corners of the paranota are produced caudad. The male gonopods are strikingly similar in both size and form, the primary difference being the presence of a caudally directed twist just beyond the mid-point of the postcingular portion of the telopodite of the gonopod of *B. electa*. This twist is not present in *B. ochra initialis*.

The differences between *B. electa* and *B. ochra initialis* are so slight that it is possible that *B. electa* eventually will be shown to be a subspecies of *B. ochra*. The two forms are being left separate, however, until such time as further collecting reveals the true situation.

Brachoria eutypa eutypa Chamberlin

FIGURE 3a-g

Brachoria eutypa Chamberlin, Bull. Univ. Utah, biol. ser., vol. 5, No. 3, p. 4, fig. 4, 1939.

DIAGNOSIS: Distinguished from all other species of the genus except *hansonia*, *plecta*, and *separanda* by the medium size, and slender, simple form of the gonopods. Differs from *hansonia* and *separanda* in that the extreme distal end of the telopodite of the gonopod is

always slightly hook-shaped while the telopodite in both *hansonia* and *separanda* narrows gradually to a pointed tip. Differs from *separanda* and *plecta* in that the portion of the telopodite just distal to the cingulum is not noticeably larger than the portion just proximal to the cingulum. Distinguished from *eutypa ethotela* by the absence of a swelling just proximal to the distal end of the telopodite.

DESCRIPTION: Length of holotype, 38 mm.; width, 9.8 mm.; length of other males, 37–44 mm.; width, 9–11 mm.; length of females, 43–46 mm.; width, 10.5–12.5 mm.

Collum ellipsoidal, edges gently curved, ends of paranota gently rounded; paranotal swellings extremely weak; ridges of anterior edges of paranota variable.

Paranotal swellings become increasingly more noticeable from segments 2 and 3 on, but never becoming very strong. Paranota of segment 9 and anterior segments squared at caudolateral corners; paranota of segments 10, 11, and 12 showing very slight caudad production.

Sternum of 3d pair of legs with very weak processes; processes on sternum of 4th legs barely noticeable; sternum of 5th legs with median groove but no processes; sternum of 6th legs smooth.

Coxal armature usually weak, rarely moderate.

Male gonopods of medium size (about 1.91–2.03 mm. in telopodite arc length and 1.8–2.02 mm. in arc width); simple; curved mesiad, then dorsad, then caudodorsad; extreme distal end bent to hook-like appearance; cingulum located at point on arc most remote from body; precingular portion but slightly longer than postcingular portion (in some specimens subequal). Prefemoral spine moderate.

Color dark brown above and on preanal scale; caudolateral portions of all paranota very light yellow, almost white; a median light spot on posterior margin of each tergite; collum with two median light spots, one on posterior margin and one on anterior margin; underparts tan; antennae dark brown, the last three articles darkest.

TYPE LOCALITY: Russellville, Hamblen County, Tenn.

TYPE SPECIMEN: In the private collection of R. V. Chamberlin.

NEW DISTRIBUTION RECORDS:

NORTH CAROLINA: Avery County: between Banner Elk and Newland, June 15, 1953 (1 ♂), Hoffman. TENNESSEE: Cumberland County: Crab Orchard Mountain, Crab Orchard Gap, 2 miles east of Crab Orchard, May 9, 1951 (1 ♂), Hubricht. Granger County: tulip tree woods, 6.8 miles south of Rutledge, May 19, 1956 (2 ♂, 2 ♀), Hoffman, Keeton, and Lund. Hamblen County: Russellville, June 1, 1952 (3 ♂, 2 ♀), Hoffman and P. C. Holt. Hawkins County: beechwoods, 4.3 miles northeast of Surgoinsville on Route 11 W, May 19, 1956 (2 ♂, 3 ♀), Hoffman, Keeton, and Lund. Jefferson County: 2.3 miles north of Dandridge (1 ♀) and 2 miles north of Jefferson City (2 ♂, 1 ♀), May 19, 1956, Hoffman, Keeton, and Lund. Sullivan County: Worley Cave Sink, 2.5 miles east of Bluff City, May 2, 1951 (7 ♂, 1 ♀), Hubricht. Washington County: oak woods, 3 miles east of Jonesboro, May 3, 1951 (3 ♂, 1 ♀), Hubricht.

Brachoria eutypa ethotela Chamberlin, new combinationFIGURE 3*h-j*

Brachoria ethotela Chamberlin, Bull. Univ. Utah, biol. ser., vol. 6, no. 8, p. 5, fig. 13, 1942.

DIAGNOSIS: Distinguished from all other species of the genus except *hansonia*, *plecta*, and *separanda* by the medium size and slender, simple form of the gonopods. Differs from *hansonia* and *separanda* in that the distal end of the telopodite of the gonopod is somewhat swollen, with a hook-shaped end. Differs from *separanda* and *plecta* in that the portion of the telopodite just distal to the cingulum is not noticeably larger than the portion just proximal to the cingulum. Distinguished from *eutypa eutypa* by the presence of a swelling just proximal to the distal end of the telopodite.

DESCRIPTION: Length of holotype, not given; width, 9 mm.; length of other male specimens, 37–41 mm.; width, 8–10 mm.; length of female, 41 mm.; width, 9 mm.

Collum ellipsoidal, edges gently curved, ends of paranota broadly rounded; paranotal swellings extremely weak or absent; no ridges extending along cephalic edges of paranota.

Paranotal swellings either extremely weak or absent on segments 2 and 3, very slightly stronger on segment 4, never very strong on any segment. Paranota of segments 2–7 gently rounded; those of succeeding segments, including 9th, more abruptly rounded; paranota of segments 16, 17, and 18 not very sharply triangular.

Sterna of 3d and 4th pairs of legs with well-developed processes; sternum of 5th legs with pair of weak processes; sternum of 6th legs ridged in some specimens, smooth in others.

Armature of prefemora of postgenital legs not quite as strong as in *initialis*. Coxal armature of males weak to moderate.

Male gonopods of medium size (about 2.03 mm. in telopodite arc length and 2.12 mm. in arc width); simple; curved mesiad, then dorsad in continuous arc; extreme distal end bent to hook-like appearance; a noticeable swelling just proximal to distal end; cingulum located at point on arc just proximal to point most remote from body; pre-cingular portion slightly longer than postcingular portion. Prefemoral spine moderate.

Color very dark brown above and on preanal scale; bright yellow on caudolateral portion of all paranota, including collum; a small median yellow spot on anterior margin of collum; distal half of last tergite yellow; underparts and legs light brown; antennae dark brown, last three joints darkest.

TYPE LOCALITY: Marion, Smyth County, Va.

TYPE SPECIMEN: In the private collection of R. V. Chamberlin.

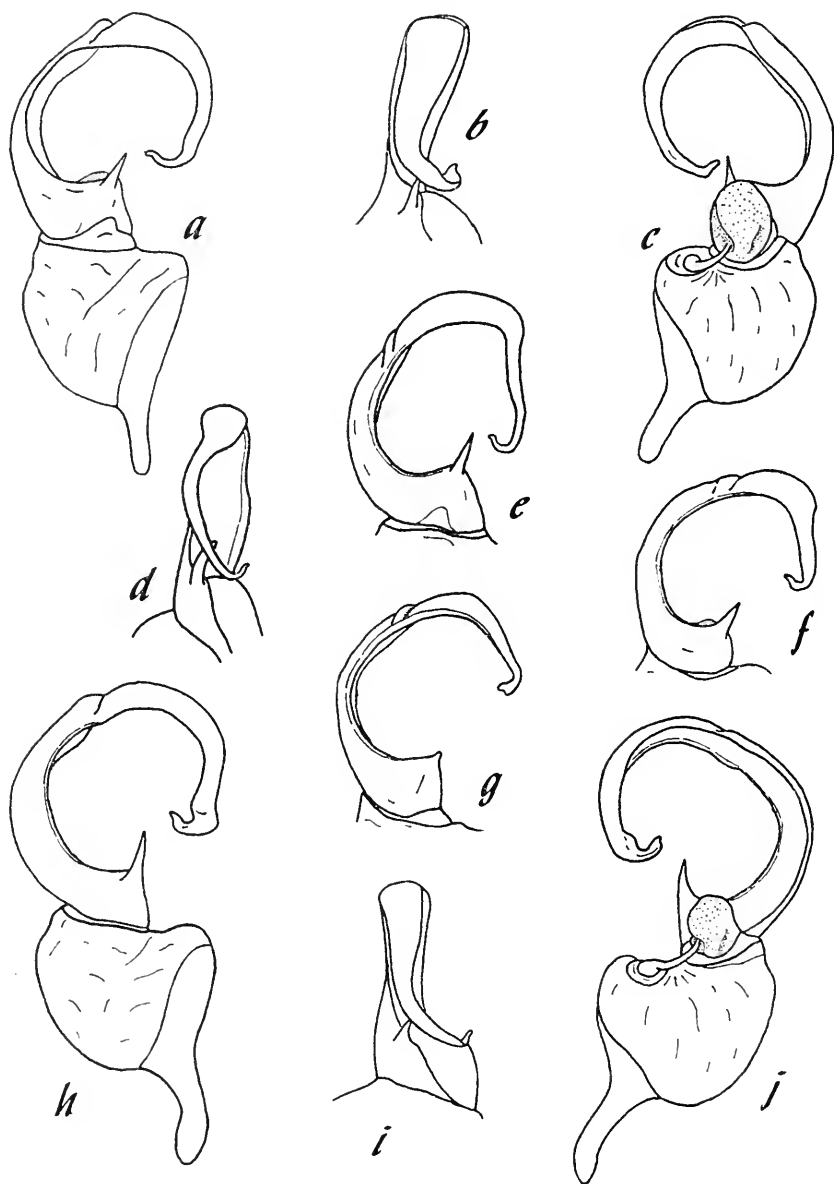


FIGURE 3.—Left male gonopods of subspecies of *Brachoria eutypa*. *a-c*, Topotype of *B. e. eutypa*: cephalic, mesial, and caudal views. *d, e*, *B. e. eutypa* from Cumberland County, Tenn.: mesial and cephalic views showing long, slender telopodite. *f*, *B. e. eutypa* from near Bluff City, Tenn.: cephalic view showing short telopodite. *g*, *B. e. eutypa* from Avery County, N. C.: cephalic view showing reduced prefemoral spine. *h-j*, *B. e. ethotela*: cephalic, mesial, and caudal views.

NEW DISTRIBUTION RECORDS:

VIRGINIA: Grayson County: Mount Rogers, elevation 4,800 feet, Aug. 3, 1955 (1 ♂), Hoffman; same location, Aug. 20, 1955 (1 ♂), V. P. I. expedition. Washington County: Konnarock, Aug. 2, 1941 (1 ♂); Neals Farm near Damascus, Aug. 18, 1941 (1 ♂, 2 ♀), Dr. and Mrs. S. T. Brooks.

DISCUSSION: This species brings to our attention one of the most interesting problems in diploped taxonomy, that of subspeciation. For many years it has been customary to designate each new form as a full species. This has often been a justified procedure inasmuch as many of the forms concerned have been known from only a few specimens and ranges have been poorly understood.

More recently, however, systematic collecting has often revealed the presence of intermediate forms so that it is now known that what were formerly considered full species are actually geographical populations forming distribution series with intergrades occurring at the borders of the populations.

This phenomenon has been studied in several genera of the Xystodesmidae by Hoffman (1951) and he has considered that it represents subspeciation of a type comparable with that found in many vertebrate groups such as fish, amphibians, reptiles, etc.

Some workers have recently been rather strong in their denunciation of the subspecies concept. They maintain that the subspecies as now used has no reality and only tends to confuse understanding of variation and to add a needless multiplicity of names. It is my belief that this criticism goes too far. It is true that the subspecies concept must be used with caution and that it has often been misused. This does not mean, however, that the concept is invalid or should be abandoned. There are in biology many instances of continuous clines of variation and it seems obvious that attempts to arbitrarily delimit stages in these continua and call them subspecies are ill-advised and can only be misleading. The value of the subspecies category is apparent in those cases where the spatial isolation of the unit populations is more nearly complete.

It is my feeling that *Brachoria eutypa* illustrates a case where subspecies designation is not only appropriate but is the most adequate method of describing the facts as they are now known. In addition this species provides a good example of clinal variation.

Brachoria eutypa was described by Chamberlin from Hamblen County, Tenn., in 1939. In 1942, Chamberlin described *Brachoria ethotela* from Marian, Va. These two forms differed from each other in several particulars. The postcingular portion of the telopodite of the male gonopods is often considerably longer and somewhat thinner in *eutypa*. The distal end of the telopodite of *ethotela* is heavier and slightly more complex. In addition, *eutypa* has the tri-

maculate body color pattern while *ethotela* has the bimaculate pattern. These differences have seemed sufficient to maintain the two as separate species until the present time.

Recently, however, a series of specimens from the extreme north-eastern part of Tennessee has been found to exhibit characters intermediate between *eutypa* and *ethotela*. These specimens are not only intermediate in the form of the male gonopods but show interesting variation in color pattern as well. Most of these specimens show the trimaculate pattern like *eutypa* but some few have the bimaculate pattern typical of *ethotela*. It seems obvious that the existence of these intermediate specimens in the area where the ranges of *eutypa* and *ethotela* join makes it necessary to regard the two as only subspecifically distinct.

Study of a number of collections of *eutypa eutypa* from various parts of Tennessee has shown that clinal variation is very evident within this subspecies. Indeed, I at first thought that at least two different subspecies were involved. Extensive collecting has shown, however, that the characters change gradually as one moves from northeastern Tennessee towards the west or southwest. The postcingular portion of the telopodite of the male gonopod becomes longer and more slender and the collum ridge becomes more and more evident. The latter character is of special interest inasmuch as it is constant within species in most instances.

An interesting specimen collected in Avery County, N. C., may represent another subspecies, but it is being considered an aberrant specimen of *eutypa eutypa* until such time as more collecting reveals the true situation. This specimen has the telopodite of the male gonopod of the typical *eutypa* form, but the usually moderately strong prefemoral spine is reduced to a small nub (fig. 3g). This is more variation than would normally be expected, but inasmuch as variation in this character, albeit to a lesser extent, is known in other species such as *B. insolita*, it seems insufficient for separate nomenclatorial distinction when only one specimen is known. The specimen shows the bimaculate color pattern which is not the typical pattern for *eutypa eutypa*.

It is necessary that attention be called to the distribution record for Burkes Garden in southwestern Virginia given by Hoffman (1949) for *ethotela*. These specimens actually represent a new species, *Brachoria hamata* (p. 30).

The specimens upon which the distribution records for *ethotela* in Kentucky given by Causey (1955) were based have been examined by the author. The clarifications provided by the present study make it possible to identify these specimens with more certainty.

Some of them are now assigned to *Brachoria indianae* and the others to the new species *Brachoria plecta*.

***Brachoria falcifera*, new species**

FIGURE 4a-c

DIAGNOSIS: Distinguished from all other species of the genus by the very thin form of the telopodite of the male gonopods and by the distinctive shape of the distal end of the telopodite.

DESCRIPTION: Length of male holotype, 40 mm.; width, 10 mm.; length of female, 35 mm.; width, 9 mm.

Collum ellipsoidal, ends of paranota gently rounded; paranotal swellings absent, only a very weak trace of ridges on anterior edges of paranota.

Paranotal swellings nearly absent from segments 2 and 3; slightly stronger on segment 4 and all succeeding segments but never very strong. Paranota of segments 2-10 broadly rounded with no evidence of being caudally produced on corners; paranota of segments 11-14 rather square.

Sterna of 3d, 4th, and 5th pairs of legs with well-defined processes. Sternum of 6th legs smooth.

Coxal armature moderate to strong.

Male gonopods of medium size (about 2.14 mm. in telopodite arc length and 1.68 mm. in arc width); of very slender form; simple; curved mesiad, then cephalomesiad, then cephalodorsad, then dorsolaterad in continuous arc; extreme distal end curving ventrocaudad; distal portion of telopodite distinctly sickle-shaped; cingulum located at point of strongest mesial curvature; precingular portion and postcingular portion subequal in length. Prefemoral spine moderate.

Color in life black, with caudolateral corners of paranota and caudal edges of tergites reddish pink; underparts whitish, legs becoming pink distally.

TYPE LOCALITY: Grimleysville, Buchanan County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by R. L. Hoffman and W. B. Newman, June 30, 1951. Male holotype and female allotype in the U. S. National Museum.

DISCUSSION: *Brachoria falcifera* is a very distinctive species. The unique shape and extremely thin form of the male gonopods are unlike any other species of the genus. Especially interesting is the fact that this species is at present known only from the type locality in Buchanan County, Va., which is also the county in which the two new species *hoffmani* and *laminata* were found. These two forms, however, have heavy, complicated male gonopods which apparently indicate that they are phylogenetically quite distant from *falcifera*.

Brachoria glendalea (Chamberlin)

FIGURE 4d-f

Fontaria glendalea Chamberlin, Psyche, vol. 25, pp. 123-124, 1918.*Brachoria glendalea*, Chamberlin and Hoffman, U. S. Nat. Mus. Bull. 212, p. 24, 1958.

DIAGNOSIS: Distinguished from all other species in the genus by the small size, by the simple but broad flat form of the telopodite of the male gonopod, and by the fact that the arc is completed quite distant from the base of the telopodite.

DESCRIPTION: Length of male holotype, 39 mm.; width, 10 mm.; length of other male specimen, 36 mm.; width, 10 mm.

Collum ellipsoidal, edges gently curved, ends of paranota rounded; paranotal swellings extremely weak; moderately strong ridges extending from ends of paranota along their cephalic edges to points at level of their bases.

Paranotal swellings extremely weak on segment 2, much more evident on segment 3 and all succeeding segments. Paranota of mid-body segments rather square, 9th and succeeding segments with the caudolateral corner produced caudad very slightly.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with pair of very small, subconical processes; sterna of 5th and 6th legs smooth.

Coxal armature very weak.

Male gonopods of medium size (about 2.02 mm. in telopodite arc length and 1.13 mm. in arc width); curved mesiad, then dorsad, then laterad, entire arc being completed quite distant from base of telopodite; telopodite blade rather broad and flat, distal end tapering to a subacute point; cingulum located just distal of point of initial mesial curvature; precingular portion longer than postcingular portion. Prefemoral spine moderate.

Color dark brown above with paranota entirely yellow except for a very small bit of mesocephalic portion; no median light spot on collum; antennae dark brown; underparts and legs very light brown.

TYPE LOCALITY: Glendale Hills, Nashville, Davidson County, Tenn.

TYPE SPECIMEN: In Museum of Comparative Zoology, Cambridge, Mass.

NEW DISTRIBUTION RECORDS:

TENNESSEE: Hickman County: Duck River bluff north of Centerville, Sept. 24, 1955 (1 ♂), Hubricht. Perry County: near Campbell Cave, 2.5 miles east of Linden, June 16, 1957 (1 ♂), Hubricht.

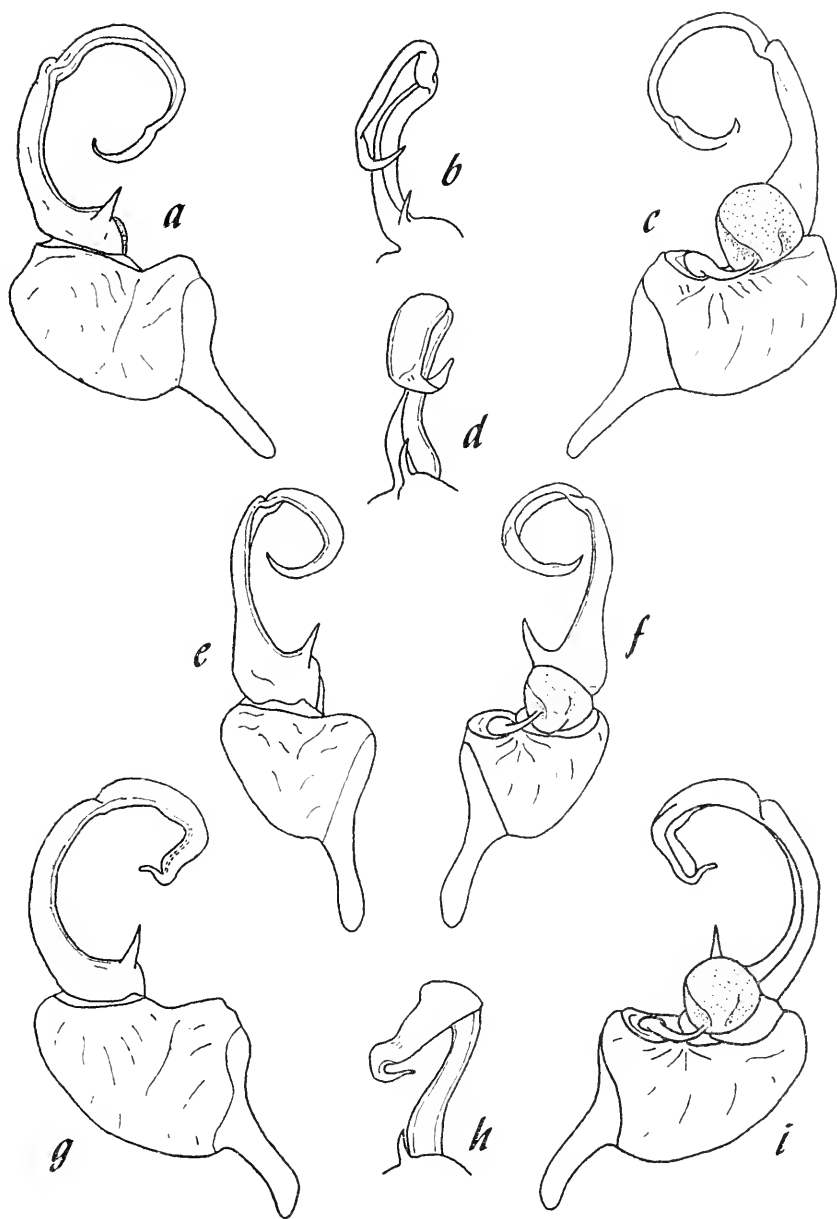


FIGURE 4.—Left male gonopods of species of *Brachoria*. *a-c*, *B. falcifera*: cephalic, mesial, and caudal views. *d-f*, *B. glendalea*: mesial, cephalic, and caudal views. *g-i*, *B. hamata*: cephalic, mesial, and caudal views.

Brachoria hamata, new species

FIGURE 4g-i

DIAGNOSIS: Distinguished from all other species of the genus by the strongly developed hook on the end of the telopodite of the male gonopod, the distal portion of which is abruptly reduced in size.

DESCRIPTION: Length of male holotype, 38 mm.; width, 9 mm.; length of female allotype, 39.5 mm.; width, 11 mm.

Collum ellipsoidal, edges gently curved, ends of paranota broadly rounded; paranotal swellings absent; no ridges on cephalic margins of paranota.

Paranotal swellings absent from segments 2 and 3, weakly evident on segment 4 and all succeeding segments. Paranota of midbody segments, including those of 9th segment, rounded; paranota of 17th and 18th segments not very sharply triangular.

Sterna of 3d-6th pairs of legs with well-developed processes.

Coxal armature weak in male, moderately strong in female.

Male gonopods of medium size (about 2.03 mm. in telopodite arc length and 1.8 mm. in arc width); curved gradually mesiad, then mesiodorsad, then abruptly laterodorsad, tip bent abruptly lateroventrad; distal tip of telopodite abruptly much smaller than portion just proximal to it; cingulum located just proximal to point on arc most remote from body; precingular portion longer than postcingular portion. Prefemoral spine moderate.

Color, dorsally black, caudolateral corners of paranota bright orange in life.

TYPE LOCALITY: Beartown Mountain, about 4,600 feet in elevation, Burkes Garden, Tazewell County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by R. L. Hoffman and H. I. Kleinpeter, June 29, 1947. Male holotype and female allotype in the U. S. National Museum.

DISCUSSION: The new species *Brachoria hamata* is based upon a group of specimens from Burkes Garden, Va., first reported by Hoffman (1949) as *Brachoria ethotela*. Careful examination has convinced me that they are actually quite distinct from *ethotela*, and they are here given full specific recognition.

This species is of considerable interest inasmuch as it has so far been found only in the unusual Burkes Garden area and is thus another example of the very distinctive fauna of that locality.

Burkes Garden is a large anticlinal, limestone valley on the west side of Clinch Mountain. The almost completely enclosed condition of the valley and its high elevation have resulted in most unusual ecological conditions. Distribution records for the area have often

been found to be very different from those in the surrounding areas. Hoffman and Kleinpeter (1949) and Hoffman (1955) have studied the herpetological fauna of Burkes Garden in recent years and some of their findings are very striking. It is not unexpected, then, that the diplopod fauna of the region should also be distinctive. More extensive collecting will doubtless reveal many more facts of interest to students of millipeds.

The specific name refers to the hooklike development of the male gonopods.

Brachoria hansonia Causey

FIGURE 5a-c

Brachoria hansonia Causey, Ent. News, vol. 61, pp. 6, 7, fig. 1, 1950.

DIAGNOSIS: Distinguished from all other species of the genus except *separanda* and *hubrichti* by the completely simple form and large size of the telopodite of the male gonopods. Differs from *separanda* in not having an enlargement of the telopodite just distal to the cingulum and in the smooth curve of the telopodite arc with no abrupt bends. Differs from *hubrichti* in the more slender form of the telopodite and in the acuminate distal end.

DESCRIPTION: Length of holotype, 49 mm.; width, 11 mm.; length of females, 51 mm.; width, 11 mm.

Midbody paranota, including those of 9th segment, rather square. Paranota of segments 17 and 18 not very sharply triangular.

Sternum of 3d pair of legs with the usual processes; sterna of 4th and 5th legs with well-developed processes; sternum of 6th legs smooth.

Male gonopods rather large (about 2.6 mm. in telopodite arc length and 1.9 mm. in arc width); completely simple; curving mesiad, then dorsad, the tip laterad, all in a continuous smooth arc; cingulum located just distal to point of initial mesial curvature; precingular and postcingular portions subequal. Prefemoral spine moderate.

Color faded.

TYPE LOCALITY: Kentucky Ridge State Forest, Pineville, Bell County, Ky. Known only from the type locality.

TYPE SPECIMEN: In Academy of Natural Sciences of Philadelphia.

Brachoria hoffmani, new species

FIGURE 5d-f

DIAGNOSIS: Distinguished from all other species of the genus except *laminata* by the presence of a thin terminal plate on the telopodite of the male gonopods. Differs from *laminata* in the much longer postcingular portion of the telopodite, and the shape and complexity of the terminal plate.

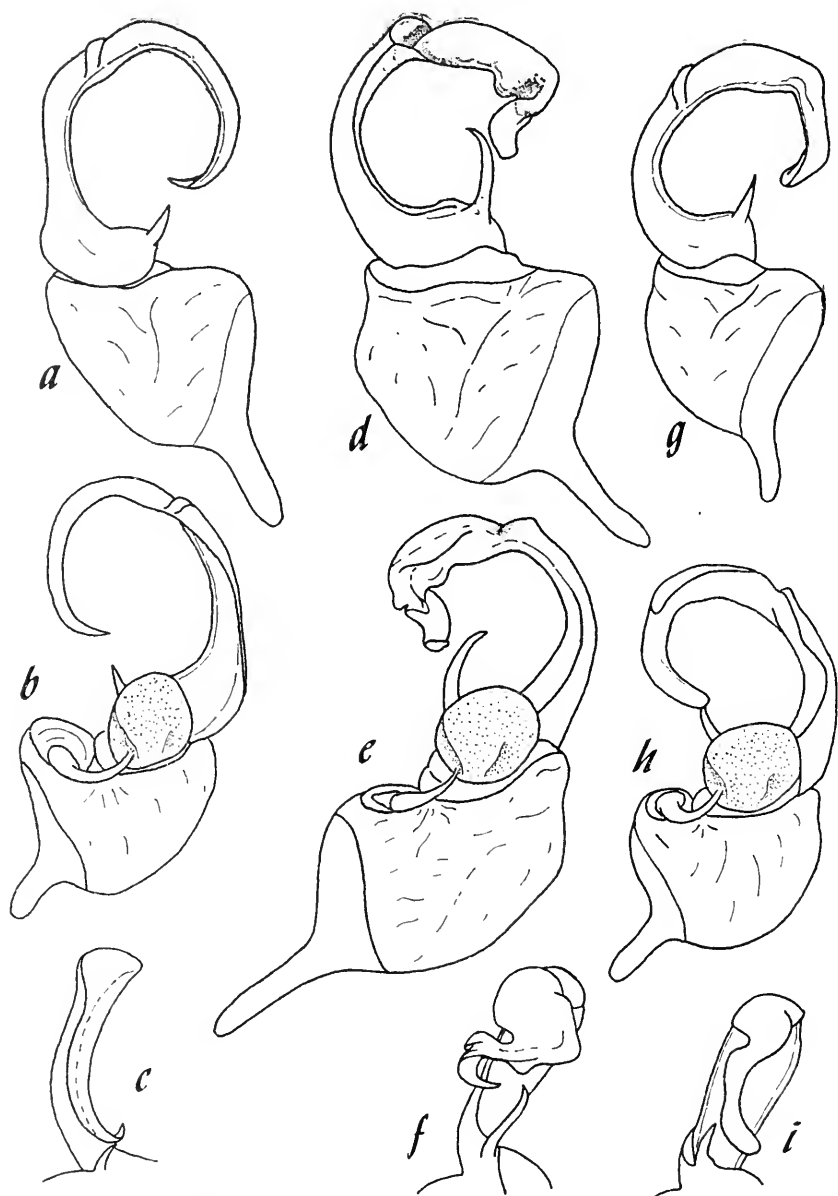


FIGURE 5.—Cephalic, caudal, and mesial views of left male gonopods of species of *Brachoria*.
a-c, *B. hansonia*, holotype; d-f, *B. hoffmani*; g-i, *B. hubrichti*.

DESCRIPTION: Length of male holotype, 43 mm.; width, 10.5 mm.; length of male paratype, 41.5 mm.; width, 10 mm.; length of female, 47 mm.; width, 11.5 mm.

Collum ellipsoidal, ends of paranota narrowly rounded; paranotal swellings weak; strong ridges along cephalic edges of paranota.

Paranotal swellings present but weak on segments 2 and 3, stronger on succeeding segments. Paranota of midbody segments, including 9th, rather square. Paranota of segments 16–18 bluntly triangular.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with pair of small processes; sterna of 5th and 6th legs without processes.

Coxal armature strong.

Male gonopods large (about 2.36 mm. in telopodite arc length and 2.22 mm. in arc width); curved cephalomesiad, then mesiad in a smooth arc, beyond this point bent abruptly cephalolaterad, terminal plate directed laterodorsad for a very short distance, then directly dorsad, its distal end bent abruptly caudad; postcingular portion of telopodite very complex and heavy, inner side with several prominent ridges, a thin terminal plate on distal end, this plate longer than broad; cingulum very prominent, located at point on arc most remote from body; precingular portion of telopodite longer than postcingular portion. Prefemoral spine very long.

Color somewhat faded but indicates dark brown dorsum with light paranota and a light band across caudal border of each tergite.

TYPE LOCALITY: Vansant, Buchanan County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by R. L. Hoffman and W. B. Newman, July 2, 1951. Male holotype, male paratype, and female allotype in the U. S. National Museum.

DISCUSSION: *Brachoria hoffmani* is a species with exceedingly complicated gonopods. The postcingular portion of the telopodite is rather *Tucoria*-like except in its length while in other respects, particularly the very strongly developed prefemoral spine, the gonopod resembles the old conception of *Brachoria*.

I take great pleasure in naming this species for my very good friend Richard L. Hoffman whose constant help and guidance have made this paper possible.

Brachoria hubrichti, new species

FIGURE 5g-i

DIAGNOSIS: Distinguished from all other species of the genus except *hansonia* and *separanda* by the size and completely simple form of the

telopodite of the male gonopod. Differs from *hansonia* and *separanda* in the considerably stouter nature of the telopodite.

DESCRIPTION: Length of male holotype, 41 mm.; width, 9.5 mm.; length of female allotype, 44 mm.; width, 11 mm.; length of other male, 46 mm.; width, 11 mm.

Collum subellipsoidal, closely resembling *initialis*, the posterior edges of paranota curved more noticeably forward than in most species of the genus, ends of paranota narrowly rounded, caudolateral corners curved rather abruptly; paranotal swellings present but weak; strong ridges along cephalic margins of paranota.

Paranotal swellings distinct on segment 2 and all succeeding segments. Segment 2 and all succeeding midbody segments, including 9th, rather square; paranota of segments 16-18 bluntly triangular.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with very weak traces of processes; sterna of 5th and 6th legs smooth.

Coxal armature moderate.

Male gonopods of medium size (about 2.1 mm. in telopodite arc length and 1.9 mm. in arc width); completely simple in form; curved gradually mesiad, then more abruptly dorsad, end curving somewhat laterodorsad; half of postcingular portion between cingulum and abrupt bend much broader than half beyond bend; cingulum located at point on arc about midway between point of initial mesial curvature and abrupt bend dorsad; precingular portion of telopodite and postcingular portion subequal. Prefemoral spine moderate.

Color: Dorsum dark brown, paranota red, underparts tan; last two joints of legs pink.

TYPE LOCALITY: McMinnville, Warren County, Tenn.

TYPE SPECIMENS: Collected by Leslie Hubricht, May 21, 1951. Male holotype and female allotype in the U. S. National Museum.

OTHER DISTRIBUTION RECORDS:

TENNESSEE: Hamilton County: Signal Mountain, July 22, 1956 (1 ♂), Hoffman. Marion County: west fork of Pryor Cove, 2 miles northeast of Jasper, June 27, 1957 (2 ♂, 1 ♀), Hubricht.

DISCUSSION: I take great pleasure in naming this species for Mr. Leslie Hubricht whose extensive collecting of millipeds has played an important role in the extension of our knowledge of the diplopod fauna of North America. Without the specimens of *Brachoria* collected by Mr. Hubricht, the present study would have been impossible.

Brachoria indianae (Bollman)

FIGURE 6a-c

Fontaria indianae Bollman, Proc. U. S. Nat. Mus., vol. 11, pp. 406-407, 1888.

Brachoria indianae, Chamberlin and Hoffman, U. S. Nat. Mus. Bull. 212, p. 24, 1958.

DIAGNOSIS: Distinguished from all other species in the genus by the combination of the small size of the gonopods and the very short, rather broad posteangular portion of the telopodite.

DESCRIPTION: Length of male lectotype, 31 mm.; width, 7.5 mm.; length of male paratype, 35 mm.; width, 9 mm.; length of female paratypes, 38–39 mm.; width, 8–9 mm.; length of other male specimens, 32–38 mm.; width, 7–8.3.

Collum subellipsoidal, ends of paranota narrowly rounded; paranotal swellings present; ridges along anterior margins of paranota.

Paranotal swellings evident on all segments. Paranota of segments 2–7 rounded, those of 8–11 more square (in some of Bollman's female specimens the caudolateral corners of the paranota of the 9th segment are slightly produced caudad).

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with very weak indications of processes; sternum of 5th and 6th legs without processes but a groove through center of sternum of 5th legs.

Coxal armature moderately strong.

Male gonopods small (about 1.6 mm. in telopodite arc length and 1.0 mm. in arc width); simple, curved gradually mesiad, then abruptly cephalodorsad; posteangular portion of telopodite short, rather broad for most of its length, narrowing towards distal end. Prefemoral spine rather large (bifid in lectotype only).

Color: Dorsum dark brown, paranota yellow, tergites sometimes narrowly margined posteriorly with yellow.

TYPE SPECIMENS: Bollman's original description mentioned three males and seven females. No holotype was designated. Two of the females and parts of the three males are in the U. S. National Museum. Inasmuch as Bollman mentioned most explicitly the specimen with bifid prefemoral spines, and since this specimen is in relatively good condition, the author hereby designates it as the lectotype specimen.

TYPE LOCALITY: Bollman mentioned both Brookville and Hagerstown, Ind. Chamberlin and Hoffman (1958) restricted the type locality to Brookville. This is the locality at which all the males were collected. Inasmuch as females are very difficult to identify, the Hagerstown record is even a doubtful one for the species.

NEW DISTRIBUTION RECORDS:

INDIANA: Clark County: upland oak woods, 1.5 miles southeast of Solon, Apr. 28, 1956 (1 ♂), Hubricht. **KENTUCKY:** Fayette County: Lexington, Oct. 1, 1894 (1 ♂), H. Garman; Richmond Road at Kentucky River, May 30, 1892 (1 ♂), H. Garman.

DISCUSSION: Bollman's description of this species mentioned the bifid nature of the basal or prefemoral spine. I have examined all three of Bollman's male type specimens. Only one shows this bifid

condition, the other two being normal. None of the other specimens examined have bifid spines. It is therefore assumed that the bifid condition is an abnormality and not typical of the species (the fact that in the one specimen both right and left gonopods show exactly the same bifid condition makes it improbable that the condition is due to the ends of the spines having been broken).

Brachoria insolita, new species

FIGURE 6d-f

DIAGNOSIS: Distinguished from all other species of the genus except *dentata* by the position of the cingulum on the telopodite of the male gonopods. Differs from all species of the genus except *mendota* in that the telopodite are is primarily in a plane oblique to the longitudinal axis of the body.

DESCRIPTION: Length of male holotype, 41 mm.; width, 9 mm.; length of other male specimens, 38-46 mm.; width, 9-10.5 mm.

Collum subellipsoidal, curvature of edges somewhat irregular, ends of paranota rounded; paranotal swellings absent; very weak ridges along cephalic margins of paranota.

Paranotal swellings absent from 2d segment, weak on 3d segment, somewhat stronger on succeeding segments. Paranota of 2d segment and all succeeding midbody segments broadly rounded. Caudolateral corners of posterior segments, including 17th and 18th, broadly rounded.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with pair of processes; sternum of 5th legs sometimes with pair of weak processes, sometimes without; sternum of 6th legs usually without processes, occasionally with a pair of very weak ones.

Coxal armature usually moderate, sometimes very weak.

Male gonopods of medium size (about 1.86 mm. in telopodite arc length and 1.8 mm. in arc width); curved gradually ventromesial, then abruptly dorsocephalad, then abruptly laterad; a tooth on caudal side of telopodite just proximal to first abrupt bend; part of postcingular portion of telopodite distal to first abrupt bend much slimmer than part proximal to bend; cingulum located at point of initial mesial curvature near base of telopodite; precingular portion of telopodite much shorter than postcingular portion. Prefemoral spine very weak, sometimes absent.

Color: Dark brown above; light (probably yellow) on paranota except on cephalomesial corners; a large light median spot on caudal margin of all tergites including collum; collum with a large light median spot on cephalic margin; underparts straw-colored.

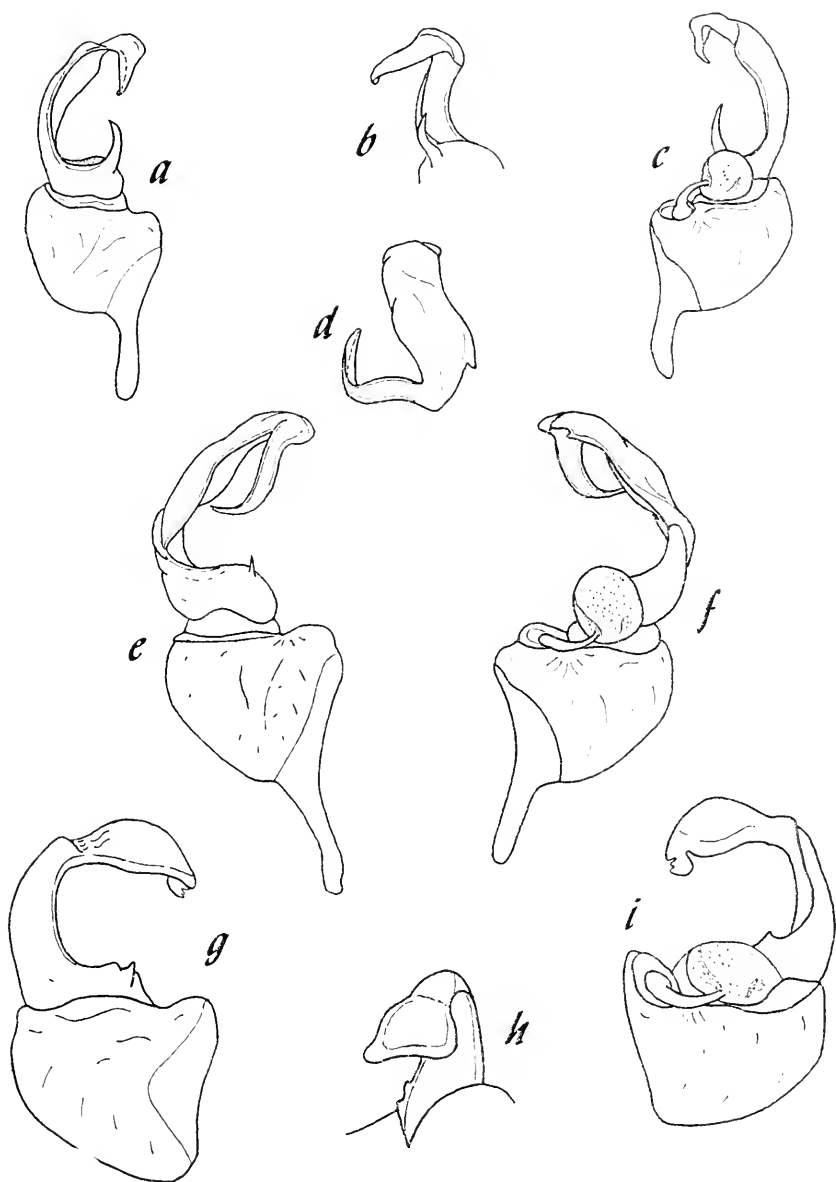


FIGURE 6.—Left male gonopods of species of *Brachoria*. a-c, *B. indianae*: cephalic, mesial, and caudal views of lectotype. d-f, *B. insolita*: ventral, cephalic, and caudal views. g-i, *B. kentuckiana*: cephalic, mesial, and caudal views of holotype.

TYPE LOCALITY: High Knob, Cumberland Gap, Wise County, Va. Known only from the type locality.

TYPE SPECIMENS: 13 males and one female collected by Leslie Hubricht, June 17, 1950. Male holotype, three male paratypes, and female allotype in the U. S. National Museum. Male paratype in the Chicago Natural History Museum. Four male paratypes in collection of Mr. R. L. Hoffman. Four male paratypes in the author's personal collection.

DISCUSSION: *Brachoria insolita* provides a good demonstration of the variability that can be expected in the prefemoral spine of the gonopod when it is typically rather weak. The drawing (fig. 6e) of the gonopods of this species shows a weak spine which is about average size for *insolita*. Of the 13 males examined by the author, most varied but little from this average size. Several, however, were slightly longer, and one showed no trace of a spine. Species with larger, heavier spines do not show this much variation.

The present species is unusual in the genus in that the telopodite arc is primarily in a plane oblique to the longitudinal axis of the body rather than in a plane perpendicular to the body as in most other species. For this reason no mesial view of the telopodite is given among the drawings of the gonopods; a ventral view is given instead. The new species *mendota* is the only other form in the genus with the gonopods showing this type of positioning.

***Brachoria kentuckiana* (Causey), new combination**

FIGURE 6g-i

Fontaria kentuckiana Causey, Ent. News, vol. 53, p. 167, figs. 3, 4, 1942.

Cleptoria kentuckiana Causey, Ent. News, vol. 54, p. 264, 1943.

Tucoria kentuckiana, Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, No. 2, p. 17, 1943.

DIAGNOSIS: Distinguished from all other species of the genus by the presence of a prominent pectinate solenomerite on the distal end of the telopodite of the male gonopod.

DESCRIPTION: Length of male holotype, 47.5 mm.; width, 11.7 mm.; length of female allotype, 52 mm.; width, 12.4 mm.

Collum with moderate anterior ridge.

Paranota of first few segments square; paranota of 9th segment with caudolateral corners produced very weakly caudad; paranota of more posterior segments more strongly produced.

Sternum of 3d pair of legs with usual processes; sterna of 4th and 5th legs each with a pair of processes; sternum of 6th legs with only weak trace of processes.

Coxal armature weak.

Male gonopods of medium size (about 1.8 mm. in telopodite arc length and 1.8 mm. in arc width); curved anteriomesiad; distal end of telopodite bearing a well-developed, dorsally directed, pectinate sole-omerite; postcingular portion of telopodite very short, thickened; precingular portion much longer than postcingular portion. Prefemoral spine reduced to a small nub.

Color according to Causey: "the dorsum is shining dark brown; head and antennae brown; ends of collum, posterior angles of keels, roughly triangular areas on tergites or borders of tergites and collum red-orange; distal half of legs red-orange; underparts and proximal half of legs pale yellow. In alcohol dorsum fades to brown and keels and legs to yellow."

TYPE LOCALITY: Cumberland Falls State Park, Cumberland County, Ky. Known only from the type locality.

TYPE SPECIMEN: In Academy of Natural Sciences of Philadelphia.

DISCUSSION: *B. kentuckiana* resembles both *calceata* and *laminata* in some respects and it is possible that more extensive collecting will reveal that the three are only subspecifically distinct.

In the drawings of the gonopods (fig. 6) no coxal apodeme is shown as this has been broken off the type specimen.

Brachoria laminata, new species

FIGURE 7a-c

DIAGNOSIS: Distinguished from all other species of the genus except *hoffmani* by the presence of a thin terminal plate on the telopodite of the male gonopod (*calceata* shows much the same shaped distal end of the telopodite but the analogous structure is not plate-like and is not as distinct from the main portion of the telopodite). Differs from *hoffmani* in that the postcingular portion of the telopodite is very short, and in the shape of the terminal plate.

DESCRIPTION: Length of male holotype, 46 mm.; width, 11 mm.; length of male paratype, 42 mm.; width, 10.5 mm.; length of female allotype, 48 mm.; width, 11.5 mm.

Cephalic edge of collum irregular in its curvature, curving gently laterocaudad from midpoint to base of paranota, then swinging slightly forward, then more laterocaudad in a gentle arc; paranotal swellings absent; weak but noticeable ridges on cephalic margins of paranota; ends of paranota rounded.

Paranotal swellings absent from 2d segment, weakly present on 3d and succeeding segments. Paranota of midbody segments, including 9th, square; paranota of segments 16-18 bluntly triangular.

Sternum of 3d pair of legs with usual processes; sterna of 4th and 5th legs each with pair of processes; sternum of 6th legs smooth.

Coxal armature strong.

Male gonopods of medium size (about 1.97 mm. in telopodite arc length and 1.9 mm. in arc width); curving dorsomesiad, then dorsocephalad in a continuous arc, terminal plate directed almost directly laterad; a large thin terminal plate on distal end of telopodite, plate with a small, subterminal, toothed solenomerite; precingular portion of telopodite much longer than postcingular portion. Prefemoral spine moderately long, heavy.

Color somewhat faded, holotype indicates a trimaculate pattern, paratype indicates a bimaculate pattern, and allotype indicates a banded pattern. Whether this degree of color variation is typical is unknown.

TYPE LOCALITY: 3 miles southwest of Vansant, Buchanan County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by R. L. Hoffman and W. B. Newman, July 1, 1951. Male holotype, male paratype, and female allotype in the U. S. National Museum.

DISCUSSION: *Brachoria laminata* is another new species which fits into the group connecting *Brachoria* and *Tucoria*. The distal portion of the telopodite is rather *Tucoria*-like but the prefemoral spine is large and strong.

This species resembles *calceata* in many respects, while *calceata* in turn resembles *kentuckiana*. It is possible that the three are only subspecifically distinct. It seems best to keep them separate at present, however, inasmuch as so little is known of their ranges and no intergrades have as yet been found.

The name refers to the terminal plate of the telopodite of the male gonopod.

Brachoria ligula, new species

FIGURE 7d-f

DIAGNOSIS: Distinguished from all other species of the genus by the rather broad flat form of the telopodite of the gonopod and the shape of the solenomerite.

DESCRIPTION: Length of male holotype, 41 mm.; width, 10.5 mm.; length of male paratype, 40 mm.; width, 10.5 mm.; length of female allotype, 45 mm.; width, 11 mm.

Collum shape very much like that described for *laminata*; no paranotal swellings present; strong ridges along proximal portions of cephalic margins of paranota; ends of paranota rounded.

Paranotal swellings absent from 2d segment of holotype, present in paratype and allotype, present on succeeding segments in all specimens. Paranota of 2d segment and all succeeding midbody segments, including the 9th, rounded.

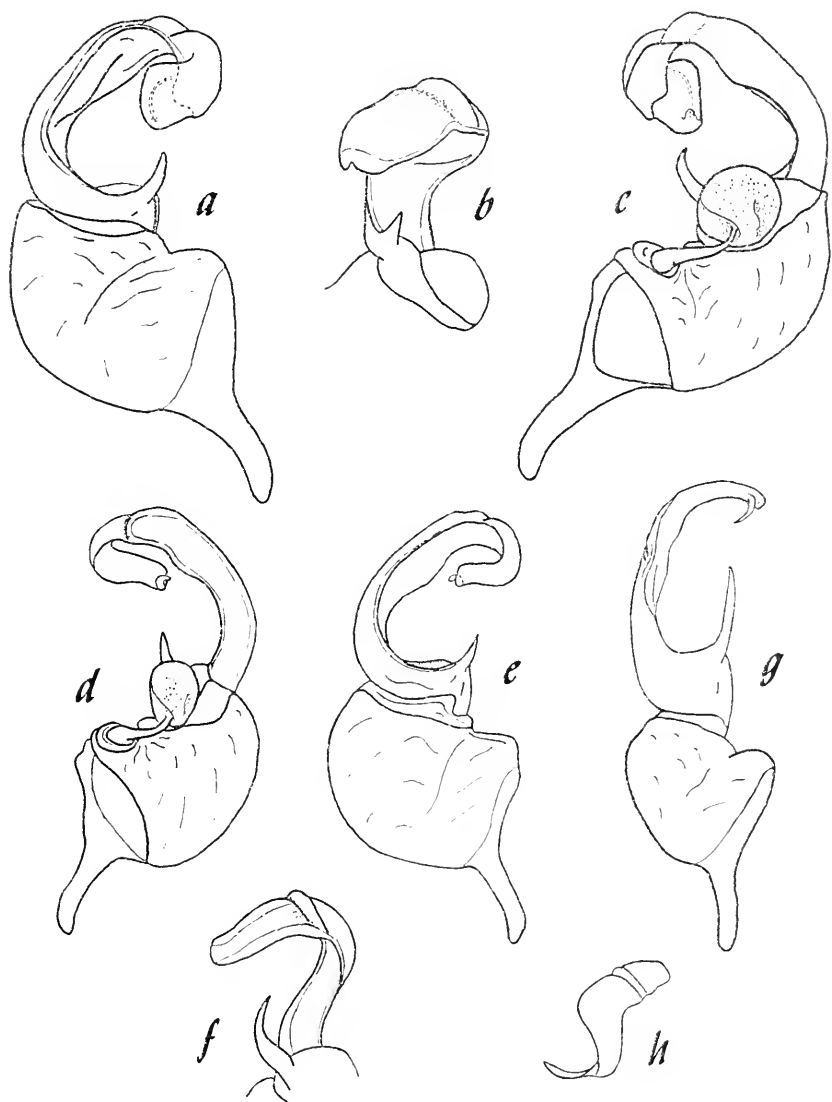


FIGURE 7.—Left male gonopods of species of *Brachoria*. *a-c*, *B. laminata*: cephalic, mesial, and caudal views. *d-f*, *B. ligula*: caudal, cephalic, and mesial views. *g*, *h*, *B. mendota*: cephalic and ventral views.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with pair of small processes; sternum of 5th legs with no trace of processes in holotype, low mounds in paratype; sternum of 6th legs with no processes.

Coxal armature well developed.

Male gonopods of medium size (about 1.9 mm. in telopodite arc length and 1.5 mm. in arc width); broad, telopodite sigmoidally curved mesiad, then cephalad, then ventrolaterad and slightly caudad in a continuous arc; a prominent tongue-like solenomerite on distal end of telopodite; precingular portion of telopodite much longer than postcingular portion.

Color faded but indicates possibility of a trimaculate pattern.

TYPE LOCALITY: 1.3 miles east of Premier, McDowell County, W. Va. Known only from the type locality.

TYPE SPECIMENS: Collected by Leslie Hubricht, June 28, 1950. Male holotype, male paratype, and female allotype in the U. S. National Museum.

DISCUSSION: *Brachoria ligula* is another new species with gonopods intermediate in form between those formerly thought typical of *Brachoria* and *Tucoria*. The general form and lack of complexity of the telopodite and the development of the prefemoral spine are all more like *Brachoria*, but the bulk of the gonopods approaches that of *Tucoria*.

The name refers to the tongue-like solenomerite.

Brachoria mendota, new species

FIGURE 7g,h

DIAGNOSIS: Distinguished from all other species of the genus except *insolita* by the fact that the distal part of the arc of the gonopods is in a plane primarily parallel to the body. Differs from *insolita* in the location of the cingulum and in the absence of a tooth on the distal part of the telopodite.

DESCRIPTION: Length of male holotype, 38 mm.; width, 8 mm.; length of male paratype, 34 mm.; width, 8 mm.

Collum subellipsoidal, ends smoothly rounded; paranotal swellings and ridges absent.

Paranotal swellings absent on segments 2 and 3, very weak on segment 4, becoming slightly stronger on more posterior segments but never strong. Caudolateral corners of all paranota rounded.

Sternum of 3d pair of legs with median longitudinal groove; sternum of 4th legs with pair of small processes; sterna of 5th and 6th legs smooth.

Coxal armature of anterior and midbody segments weak, stronger on posterior segments.

Male gonopods long (about 2.22 mm. in telopodite arc length) but the telopodite arc not very wide (about 1.06 mm.); directed almost straight ventrad, then curving smoothly cephalomesiad, then more abruptly mesiad, then rather abruptly laterocephalad; portion of telopodite distal to last bend more slender than more proximal por-

tions, this distal portion somewhat twisted; posteangular portion of telopodite slightly longer than precingular portion. Prefemoral spine large.

Color of specimens faded, pattern apparently of bimaculate type.

TYPE LOCALITY: Mendota, Washington County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by Dr. and Mrs. S. T. Brooks, July 30, 1941. Male holotype in the U. S. National Museum. Male paratype retained in the author's collection.

DISCUSSION: The form of the male gonopods in this species is so distinctive that I can detect no evidence of close relationships with any other known species of the genus.

In the illustrations of the gonopod of this species no caudal view is given inasmuch as it would show nothing not already shown in the cephalic view. In addition, a ventral view of the distal portion of the telopodite is substituted for a mesial view.

Brachoria plecta, new species

FIGURE 8a-c

DIAGNOSIS: Distinguished from all other species of the genus except *separanda* and *calcaria* by the enlarged portion of the telopodite of the male gonopod just distal to the cingulum. Differs from *separanda* in the size of the gonopod, the absence of a prefemoral spine on the gonopod, and the twisted and hooked shape of the telopodite distal to the enlarged portion. Differs from *calcaria* in all these characters and also in lacking teeth on the precingular portion of the telopodite.

DESCRIPTION: Length of male holotype, 36 mm.; width, 10 mm.; length of male paratype, 40 mm.; width, 9 mm.

Collum ellipsoidal, ends of paranota broadly rounded; paranotal swellings well defined in holotype, absent in paratype; ridges present along cephalic edges of paranota.

Paranotal swellings well defined on segment 2 and all succeeding segments in holotype; absent on 2, weak on 3, well-defined on 4 and all succeeding segments in paratype. Paranota of segments 2-6 round, those of segments 7-14 rather square; paranota of last few segments bluntly triangular.

Sternum of 3d pair of legs with usual processes; sterna of 4th and 5th legs with very small mounds; sternum of 6th legs with mounds only barely noticeable.

Coxal armature moderate.

Male gonopods of medium size (about 1.94 mm. in telopodite arc length and 1.56 mm. in arc width); curving mesiad, then cephalodorsad, then laterad, then hooked caudad; portion of telopodite just

distal to cingulum enlarged, becoming smaller again at a point about midway of length of postcingular portion; distal half of postcingular portion twisted so that erstwhile outer surface becomes caudal surface and inner surface becomes cephalic surface; end of telopodite not very acute. Precingular portion of telopodite longer than postcingular portion. Prefemoral spine absent.

Color of all specimens at hand faded.

TYPE LOCALITY: Natural Bridge, Powell County, Ky. Known only from the type locality.

TYPE SPECIMENS: Collected by H. Garman. Male holotype collected Oct. 21, 1911; male paratype, May 5, 1895. Both specimens were sent to Dr. Nell B. Causey of the University of Arkansas, who placed the holotype in the American Museum of Natural History and the paratype in the U. S. National Museum.

DISCUSSION: Although this species resembles *separanda* in having the proximal part of the postcingular portion of the telopodite of the gonopod enlarged, the resemblance seems to end there and it is felt that this does not indicate any close relationship.

This is one of the few known forms of *Brachoria* where the prefemoral spine seems to be typically entirely absent.

Study of these specimens was made possible by the cooperation of Dr. Causey, who loaned them to me.

The name refers to the twisted distal portion of the telopodite of the male gonopod.

Brachoria separanda Chamberlin

FIGURE 8g-i

Brachoria separanda Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 28, fig. 10, 1947.

DIAGNOSIS: Distinguished from all other species of the genus except *hansonia*, *ochra*, *cedra*, *hubrichti*, and *calcaria* by the completely simple form of the telopodite of the male gonopod. Differs from *hansonia* in having an enlargement of the telopodite just distal to the cingulum and in having two rather abrupt bends in the telopodite. Differs from *ochra* and *cedra* in the first of the two characters mentioned. Differs from *hubrichti* in the more slender and acuminate form of the telopodite. Resembles *calcaria* but lacks teeth on the precingular portion of the telopodite and the telopodite is more slender.

DESCRIPTION: Length of male holotype, 32 mm.; width, 6.5 mm.; length of other males, 34-38 mm.; width, 8-9 mm.

Collum ellipsoidal, edges gently curved, ends of paranota broadly rounded; paranotal swellings usually absent; ridges on cephalic margins of paranota usually absent.

Paranotal swellings usually absent from 2d segment, weakly present on 3d segment and all succeeding segments. Segment 2 and all succeeding midbody segments with paranota usually broadly rounded.

Sternum of 3d legs with usual processes; sternum of 4th legs with a pair of small processes, sternum of 5th legs usually smooth; sternum of 6th legs smooth.

Coxal armature usually moderate.

Gonopod aperture normal. Male gonopods variable in size, from about 1.6 to 2.2 mm. in telopodite arc length and 1.3 to 1.5 mm. in arc width; simple, distally subacuminate; curving mesiad, then abruptly dorsad, then abruptly laterad; cingulum large and conspicuous; precingular and postcingular portions of telopodite subequal. Prefemoral spine moderate.

Color: Dark brown above, paranota and last tergite lemon yellow, a median red spot on posterior margin of all tergites including collum, a median yellow spot on anterior margin of collum, underparts tan, distal joints of legs light pink.

TYPE LOCALITY: Jennings, Garrett County, Md.

TYPE SPECIMEN: In Academy of Natural Sciences of Philadelphia.

NEW DISTRIBUTION RECORDS:

WEST VIRGINIA: Preston County: ravine, 1.8 miles east of Erwin, June 15, 1956 (1 ♂), Hubricht. Tucker County: 6 miles south of Parsons, Oct. 1, 1938 (1 ♂, 1 ♀), G. K. MacMillan. Webster County: wooded hillside, 1 mile east of Three Forks of William's River, May 28, 1952 (2 ♂), Hubricht.

DISCUSSION: In the U. S. National Museum there is a specimen without a collection label that has gonopods very similar to the form typical of *Brachoria separanda*. This specimen differs, however, in many characters from all other known specimens of *separanda*. The distal portion of the telopodite of this specimen is extremely slender. Ridges are present on the anterior margins of the paranota of the collum; these are absent in typical *separanda*. Paranotal swellings are present on the collum and 2d segment while they are absent in these locations in *separanda*. The 9th paranota are somewhat caudally produced at the caudolateral corners while the paranota of *separanda* are broadly rounded. The coxal armature is very weak while *separanda* usually has moderate coxal armature. Weak processes are present on the sternum of the 5th legs while they are absent in typical *separanda*. Just what designation this specimen should receive, particularly in view of no collection data, is uncertain. For the moment it is considered an atypical specimen of *separanda*.

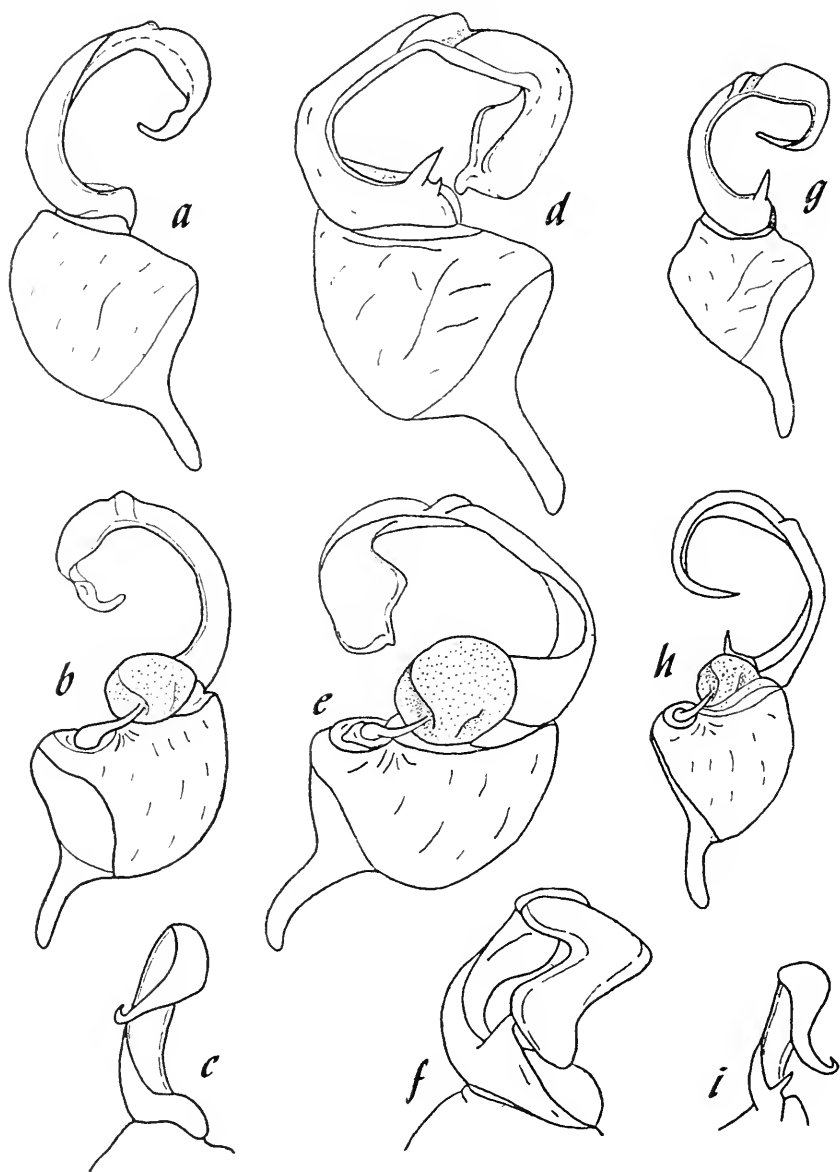


FIGURE 8.—Left male gonopods of species of *Brachoria*. *a-c*, *B. plecta*: cephalic, caudal, and mesial views. *d-f*, *B. splendida*: cephalic, caudal, and mesial views. *g-i*, *B. separanda*: *g*, cephalic view of holotype; *h*, caudal view of specimen from Webster County, W. Va., showing slightly larger gonopods; *i*, mesial view of holotype.

Brachoria splendida (Causey), new combination

FIGURE 8d-f

Cleptoria splendida Causey, Ent. News, vol. 53, pp. 167-168, fig. 5, 1942.

Tucoria splendida, Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, No. 2, p. 17, 1943.

Tucoria dynama Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 29, fig. 16, 1947.

DIAGNOSIS: Distinguished from all other species of the genus by the presence of a very pronounced ridge along the cephalic side of the distal half of the postcingular portion of the telopodite of the male gonopod.

DESCRIPTION: Length of male holotype, 49 mm.; width, 11 mm.; length of other male specimens, 45-49 mm.; width, 10-11 mm.

Collum subellipsoidal, edges somewhat irregularly curved, ends of paranota narrowly rounded; paranotal swellings absent; ridges on cephalic margins of paranota present only on proximal half.

Paranotal swellings absent on segments 2 and 3, present on 4th and all succeeding segments. Paranota of segment 2 and all succeeding midbody segments rather square, those from segment 8 on with caudolateral corners produced very slightly caudad.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with pair of prominent processes; sternum of 5th legs with pair of weak, widely separated processes; sternum of 6th legs with no processes.

Coxal armature moderate.

Male gonopods large (about 2.0 mm. in telopodite arc length and 2.7 mm. in arc width); heavy and stout; curving mesiad, then cephalo-dorsad, then dorsad; distal half of postcingular portion of telopodite very heavy and bulky, a very prominent ridge extending along cephalic side, telopodite slightly excavate on caudolateral side of this ridge, seminal groove following this ridge to its end and then moving out on peglike solenomerite; cingulum large and conspicuous; precingular and postcingular portions of telopodite subequal in length. Prefemoral spine irregular, sometimes small, sometimes moderately long and strong, often with a small accessory spine near its base.

Color dark brown above with yellow on paranota and a median yellow spot on caudal margin of each tergite including collum; collum with an additional median yellow spot on its cephalic margin, the two yellow spots almost uniting to form an hour-glass mark; legs and underparts pale yellow.

TYPE LOCALITY: Pine Mountain State Park, Bell County, Ky. This is also the type locality for *Tucoria dynama* Chamberlin.

TYPE SPECIMENS: In the Academy of Natural Sciences of Philadelphia.

NEW DISTRIBUTION RECORD:

KENTUCKY: Harlan County: Pine Mountain, July, 1946 (1 ♂), W. L. Necker and C. K. Necker.

DISCUSSION: I have examined the holotypes of both *splendida* and *dynama* and find them to be conspecific. Therefore, Chamberlin's name will have to be regarded as a synonym of *splendida*, as indicated by Chamberlin and Hoffman (1958).

Brachoria tenebrans (Hoffman)

FIGURE 9a-d

Anfractogon tenebrans Hoffman, Proc. Biol. Soc. Washington, vol. 61, pp. 94, 96, figs. 1-3, 1948.

Brachoria tenebrans, Chamberlin and Hoffman, U. S. Nat. Mus. Bull. 212, p. 25, 1958.

DIAGNOSIS: Distinguished from all other species of the genus by the shape of the distal portion of the telopodite of the male gonopod as described below.

DESCRIPTION: Length of male holotype, 43 mm.; width, 11.9 mm.; length of other male specimen, 45 mm.; width, 11.5 mm.

Collum subellipsoidal, closely resembling that of *initialis*, ends of paranota rather narrowly rounded; no paranotal swellings present; strong ridges along cephalic margins of paranota.

Paranotal swellings not present on 2d segment, present but weak on 3d segment, stronger on succeeding segments. Paranota of 2d and 3d segments with caudolateral corners rather sharp, lateral edges curving strongly cephalomesad from corner; paranota of segments 4-7 rather square; paranota of segment 8 and succeeding midbody segments with caudolateral corners produced caudad slightly.

Sternum of 3d pair of legs with usual processes; sterna of 4th and 5th legs each with pair of low moundlike processes; sternum of 6th legs smooth.

Coxal armature very weak.

Male gonopods of medium size (about 2.5 mm. in telopodite arc length and 1.7 mm. in arc width); curved mesiad, then mesiodorsad, then abruptly cephalad, then abruptly laterodorsad, then caudodorsad, then laterad; a very prominent ridge along cephalically directed portion; a prominent tooth on caudal side of dorsally directed portion in holotype, this tooth not so prominent on specimen from Lawrence County. Prefemoral spine rather short but strong.

Color faded but suggests bimaculate type pattern.

TYPE LOCALITY: Winston County, Ala.

TYPE SPECIMENS: Male holotype and male paratype in the U. S. National Museum.

NEW DISTRIBUTION RECORD:

ALABAMA: Lawrence County: Kings Cove, June 29, 1950 (1 ♂), G. E. Ball.

DISCUSSION: The author has on hand a specimen from a location considerably north of the type locality for this species. This specimen shows a number of minor differences in the distal end of the telopodite of the male gonopod. These differences are not deemed worthy of nominal recognition. For a description and drawing of the type specimen, the reader is referred to Hoffman's original description (1948a). The description given above is based primarily on the new specimen and most of the drawings are of this specimen.

This specimen, the gonopods of which more closely resemble the usual *Brachoria* type, plays an important role in the decision to consider *Anfractogon* as a synonym of *Brachoria*. The modifications of the distal end of the telopodite in this species are no more elaborate than those found in *electa* and *hoffmani* which they somewhat resemble. Unusual modifications of the distal end of the telopodite seem to be the rule rather than the exception in this genus.

Brachoria turneri, new species

FIGURE 9e-g

DIAGNOSIS: Distinguished from all other species of the genus by the combination of the simple form and great bulk of the telopodite of the male gonopods.

DESCRIPTION: Length of male holotype, 45 mm.; width, 10.5 mm.; length of females, 47-50 mm.; width, 11.5-12 mm.

Collum subellipsoidal, edges gently curved, ends of paranota rounded; paranotal swellings absent; ridges along cephalic margins of paranota absent.

Paranotal swellings absent from 2d segment, very weak on 3d segment, somewhat stronger on 4th and succeeding segments. Paranota of segments 2-4 rounded; paranota of segments 5-13 rather square; paranota of posterior segments bluntly triangular.

Sternum of 3d pair of legs with usual processes; sternum of 4th legs with pair of very weak processes; sterna of 5th and 6th legs with no processes.

Coxal armature weak.

Male gonopods large (about 2.3 mm. in telopodite arc length and 2.5 mm. in arc width); curved mesiad, then rather abruptly dorsad; portion of telopodite distal to point of strongest mesial curvature very wide, much wider than more proximal portion; a curving ridge along

causal side of distal portion of telopodite; extreme distal end of telopodite tapering to a subacuminate end; cingulum located midway between point of strongest mesial curvature and point of abrupt dorsal curvature; precingular and postcingular portions of telopodite subequal in length. Prefemoral spine weak.

Color somewhat faded but indicates dorsum was dark brown with light paranota and a light band across each tergite along caudal margin; collum with a band across cephalic margin as well.

TYPE LOCALITY: Bluff along North Fork Holston River, 2 miles southeast of Hayters Gap, Washington County, Va. Known only from the type locality.

TYPE SPECIMENS: Collected by Leslie Hubricht, July 15, 1950. Male holotype and female allotype in the U. S. National Museum. Female paratype in the author's collection.

DISCUSSION: This is another species intermediate between the old *Brachoria* and the old *Tucoria*. Assignment of *turneri* to either of these genera would have been purely an arbitrary decision. Perhaps this species, more than any other, shows that the old generic separation is untenable and should be abandoned.

I take great pleasure in naming this species for my advisor and friend, Dr. E. Craig Turner, Jr.

***Brachoria viridicolens* (Hoffman), new combination**

FIGURE 9h-j

Tucoria viridicolens Hoffman, Journ. Washington Acad. Sci., vol. 38, pp. 349-350, figs. 5, 6, 1948.

DIAGNOSIS: Distinguished from all other species of the genus by the presence of four small spines on the outer surface of the postcingular portion of the telopodite of the male gonopods.

DESCRIPTION: Length of male holotype, 40 mm.; width, 9.3 mm.

Collum subellipsoidal, ends of paranota rounded; paranotal swellings absent; presence or absence of ridges along cephalic margins of paranota unknown to author.

Paranotal swellings absent from segments 2 and 3, weakly present on segment 4 and all succeeding segments. Paranota of segments 2-4 rounded, those of segments 5-14 rather square.

Sterna of 3d, 4th, 5th, and 6th pairs of legs each with a pair of processes.

Coxal armature very weak.

Male gonopods of medium size (about 1.7 mm. in telopodite arc length and 1.8 mm. in arc width); telopodite broad; curving cephalo-

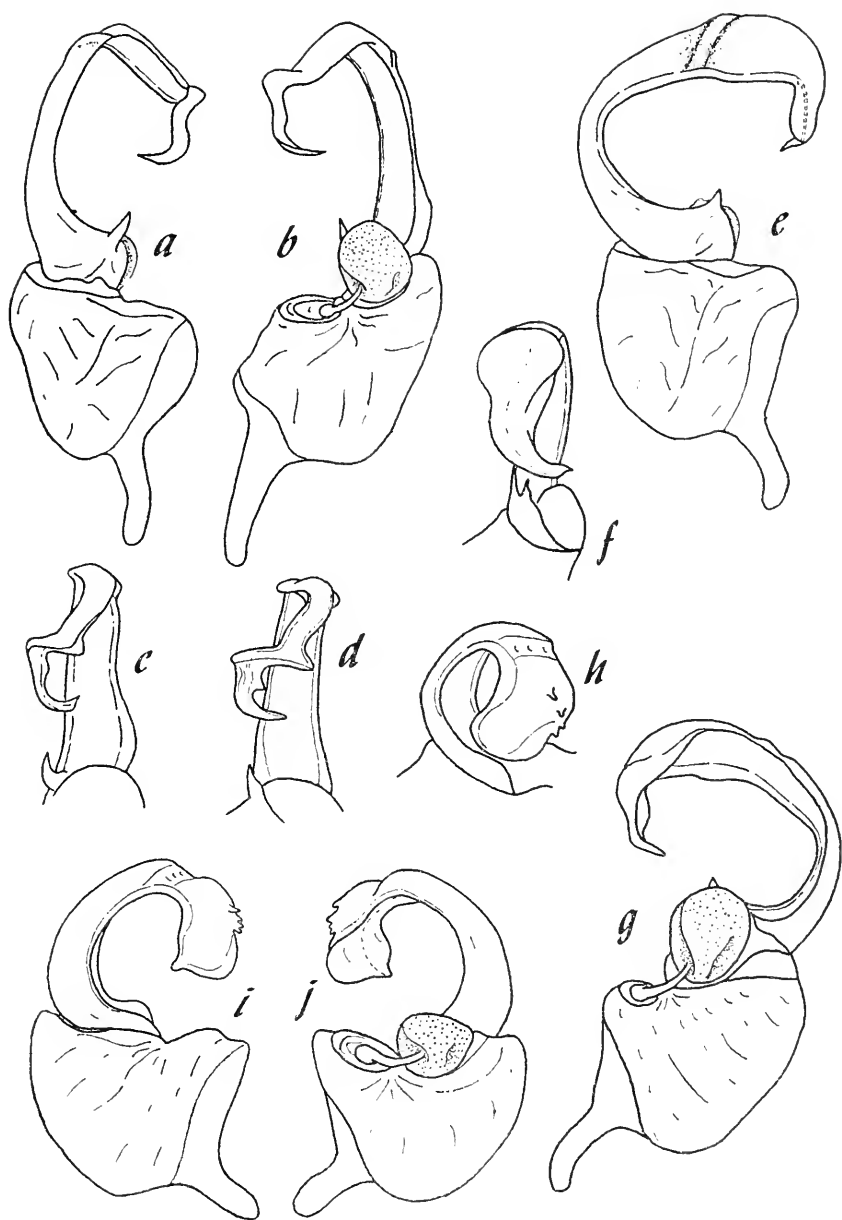


FIGURE 9.—Left male gonopods of species of *Brachoria*. *a-d*, *B. tenebrans*: *a-c*, cephalic, caudal, and mesial views of specimen from Lawrence County, Ala.; *d*, mesial view of holotype. *e-g*, *B. turneri*: cephalic, mesial, and caudal views. *h-j*, *B. viridicolens*: mesial, cephalic, and caudal views of holotype.

mesiad, then laterodorsad; 4 small sharp spines on outer surface of postcingular portion of telopodite; a small knoblike apical solenomerite; precingular portion of telopodite much longer than postcingular portion. Prefemoral spine absent.

Color faded, but indicates bimaculate pattern.

TYPE LOCALITY: Trace Creek, Greensbury, Green County, Ky. Known only from the type locality.

TYPE SPECIMEN: In the U. S. National Museum.

DISCUSSION: Although this species was first described by Hoffman (1948b) as *Tucoria viridicolens*, it lacks the complexity of the distal portion of the telopodite of the male gonopods characteristic of the other species which have in the past been referred to *Tucoria*. It is thus another form intermediate between the old *Brachoria* and *Tucoria* and adds another link to the chain of species connecting them.

Phylogenetic Relationships

Any attempt to construct an adequate picture of the phylogeny of a group with no fossil record is obviously exceedingly difficult. Decisions concerning relative primitiveness of characters are to a large extent necessarily subjective, and it follows that the process of choosing a starting point for an evolutionary tree is one fraught with opportunities for error. Even after a beginning point has been chosen, the construction of the tree itself is a matter of choosing between many possibilities, each of which may have many points in its favor. In spite of the acknowledged limitations of such studies, it is often instructive to indicate as far as possible the more probable relationships existing within any group of animals under consideration.

The distribution patterns of the species of *Brachoria* indicate that the most likely center of distribution for the genus is the general area of southwestern Virginia, southeastern Kentucky, and northeastern Tennessee. The majority of the known forms occurs in this region and, as more collecting is done, new records are being established closer and closer to the area for many species formerly known only from more distant localities.

I consider *Brachoria hansonii* to be the nearest of the known species to the primitive type of the genus. The form of the male gonopod in this species is very simple in its structure and could easily have given rise to the more complex gonopods of the other species. In addition, it most closely approaches the basic form in related genera such as *Apheloria* and *Sigmoria*. Indeed, if the cingulum were not present there could be no hesitation about placing *hansonii* in *Apheloria*.

It seems probable that *Brachoria separanda* arose from the *hansonii* stock and developed the swollen portion of the telopodite of the

gonopod and the two very noticeable bends in the telopodite. Apparently *calcaria* is a more specialized derivative of this line.

The two subspecies of *eutypa* and the more highly specialized *hamata* are obviously closely related, the prototype of the former probably giving rise to the latter. These species show resemblances to *separanda*. Another species, *plecta*, provides some evidence for this connection, as it has the swollen portion of the telopodite found in

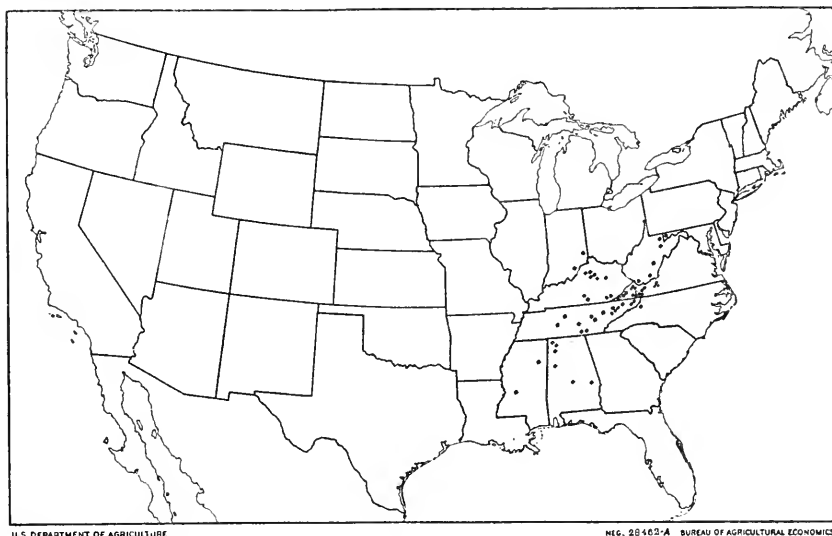


FIGURE 10.—Distribution of the genus *Brachoria*. The dots indicate the known localities from which specimens have been collected.

separanda but more distally it resembles *eutypa*. Though the twisted nature of the distal portion of the telopodite and certain body characters to be mentioned later indicate that this species is somewhat specialized, it may have arisen from an early branch of the *separanda* line that also gave rise to the *eutypa* line.

One other species should be mentioned here. Though the gonopods of *turneri* are large and heavy, their form is simple and there is no solenomerite. It seems possible that this species is an early derivative of the *separanda* line, which has independently attained larger gonopods. Thus it appears that the large bulk formerly thought to distinguish *Tucoria* does not always even indicate close relationships.

With the exception of *Brachoria plecta*, all the above species show one gonopod character in common. When viewed mesially, the telopodite arc tends to curve caudally. In addition, most of them agree in certain body characters which will be discussed later. On the basis of these characters, another group of species seems to be naturally

separated from the *separanda* group in spite of some superficial similarities between the less specialized members of the two groups. When viewed mesially, the telopodite arcs of the gonopods of the members of this group tend to curve cephalically, though the more primitive species show this condition only slightly.

The type of the genus, *B. ochra initialis*, has gonopods but little advanced over the basic type. The curvature tends only slightly cephalically. The sharp bend in the telopodite is distinctive. Apparently *cedra* and *electa* are derivatives of the *ochra* line. Both show indications of the same kind of telopodite bend as that occurring in *ochra*. *B. tenebrans*, though highly specialized, is easily derived from an *ochra*-like ancestor by modification of the distal portion of the telopodite and increase in gonopod size. The sharp bend and shoulder of *ochra* and *cedra* is still retained in this species.

Slightly advanced over the *ochra* group and lacking the sharp bend in the telopodite is *indianae*. In this species the curvature of the telopodite typical of this second major branch of the genus is very pronounced. The general form of the gonopods still somewhat resembles *ochra*. The gonopods are still small as are those of *ochra*, *cedra*, and *electa*. It would seem that *indianae* arose from the early *ochra* line before the sharp bend had arisen in the latter species.

This branch of the genus apparently led to a group of species with heavy, bulky, complex gonopods. Speculations regarding relationships within this group are exceedingly difficult inasmuch as there are many conflicting matters to consider. Characters that must be considered include the size and bulk of the gonopods, the presence or absence of a solenomerite, the presence or absence of a terminal plate, the relative length of the postcingular portion of the telopodite, and the complexity of the form of the gonopods. Which of these characters is more important as an indication of relationships is unknown. Since different conclusions can be reached depending on which characters are stressed, it must again be emphasized that the possible relationships shown in the accompanying diagram are open to much question.

The three species *viridicolens*, *kentuckiana*, and *calceata* have much smaller gonopods than do the other members of this group. This would seem to indicate that they are more primitive. In most of the other characters mentioned above, however, they are much advanced and apparently highly specialized. Another species, *ligula*, has much simpler, less bulky gonopods but they are considerably larger. In this instance I believe it probable that small gonopods have been maintained from the early *ochra-indianae* stock and that those species such as *ligula*, *splendida*, *laminata*, and *hoffmani* with larger gonopods have each independently evolved this characteristic.

B. ligula seems to be near the main line leading from the early *indianae* type to the more complex types in this group. In this species there is a noticeable increase in the bulk of the gonopods and a solenomerite has been developed.

It seems quite probable that the line leading from *ligula* to the more highly specialized forms in the group split into two main branches, one leading to *viridicolens* and eventually to the more complex *splendida*, and the other leading to the forms with terminal plates or homologous structures and typically with toothed solenomerites. Within the latter group, *calceata*, *laminata*, and *kentuckiana* all rather closely resemble each other and it would be difficult to say with any assurance just what their true relationships are. One possible grouping is shown in the diagram.

B. hoffmani presents a perplexing problem. This species has a terminal plate but no solenomerite. In addition, the postcingular portion of the telopodite is long, while it is very short in both *laminata* and *kentuckiana* and but little longer in *calceata*. Placing *hoffmani* in any scheme of relationships is thus quite difficult. It is without doubt a highly specialized form and its true affinities have been obscured. For want of a better solution, *hoffmani* is shown in the phylogeny diagram (fig. 11) as arising early from the *calceata* line.

It is interesting to note that, with the exception of *hoffmani*, there seems to be a general tendency in the entire *ligula* group towards reduction in the length of the postcingular portion of the telopodite.

The three species *glendalea*, *hubrichti*, and *falcifera*, though easily derived from the *hansonia* type, do not seem to fit well into either of the above-mentioned major groups. Therefore, each is considered to have arisen independently from the *hansonia* line.

All the above speculations as to phylogeny were based primarily on gonopod characters. On this basis the accompanying diagram was drawn. After this had been done, two other characters not previously considered were selected and the evidence presented by them was compared with the diagram. These two characters—the ridge of the collum and the shape of the midbody paranota—are not in any way associated with the genitalia, yet they show much agreement with the relationships shown. In general the species on the right side of the chart (excluding the *dentata-insolita* group which will be mentioned later) have no collum ridge and have rounded paranota, while those on the left side have collum ridges and square or produced paranota. Exceptions in the case of collum ridges are *plecta* and some specimens of *eutypa eutypa*. Exceptions in the case of the midbody paranota are *plecta*, *eutypa eutypa*, *turneri*, and *ligula*. The first three have square paranota but there is no indication of their being caudally produced at the caudolateral corners. *B. ligula* is the only species

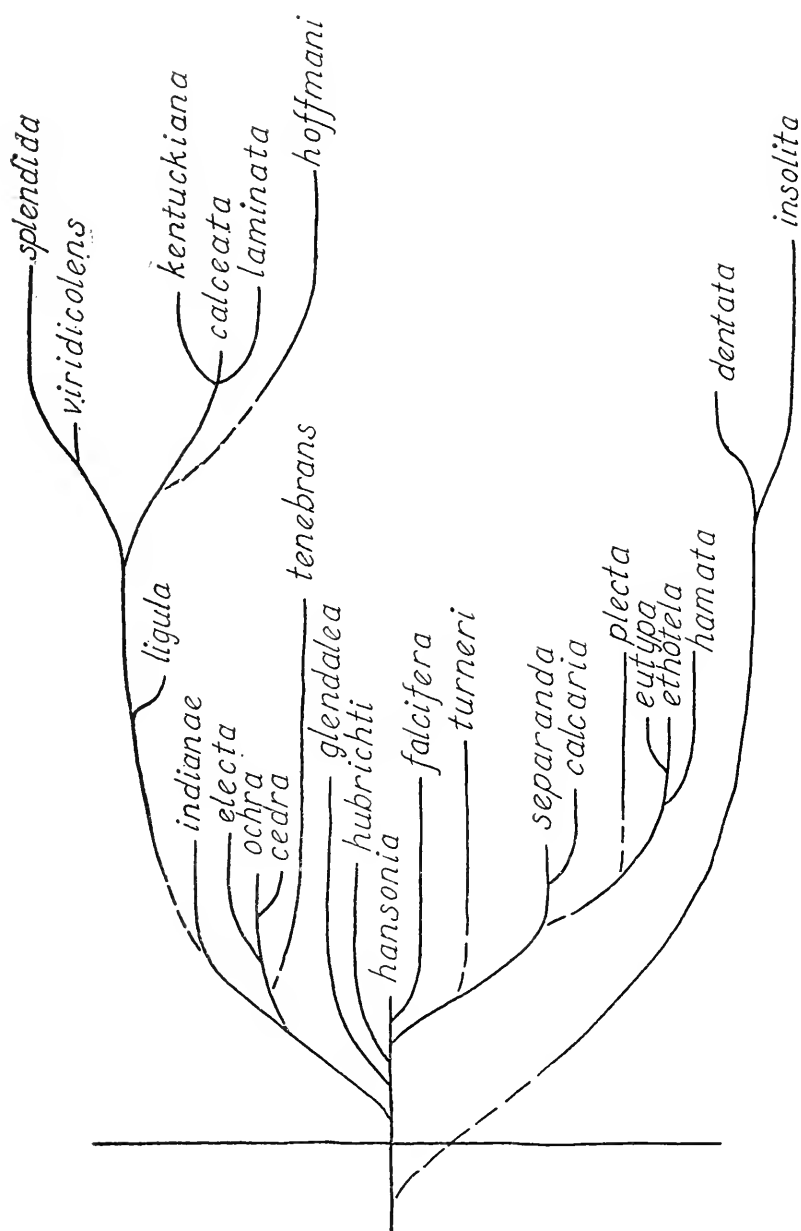


FIGURE 11.—Diagram of possible phylogenetic relationships of the species of the genus *Brachoria*.

on the left side of the chart that has rounded paranota. It is interesting to note that, in both body characters mentioned, *plecta* and *eutypa eutypa* fail to agree with their group. This would appear to be a secondary condition inasmuch as their gonopods definitely link them with the *separanda* main group.

The two species *insolita* and *dentata* obviously form a group to themselves on the basis of the location of the cingulum. They are believed to have diverged very early from the ancestral line of the genus.

No attempt has been made to show *mendota* in the phylogeny diagram as it is so highly specialized that, at present, its relationships are totally obscure to me.

It is to be hoped that extensive collecting in the future will help to clear up many of the perplexing questions indicated above. The true and complete picture will doubtless never be known, but perhaps in time the over-all trends can be established. If the purely speculative suggestions made in this paper help to stimulate further inquiry, they will have served their purpose.

Literature Cited

BOLLMAN, CHARLES H.

1888. Catalogue of the myriapods of Indiana. Proc. U. S. Nat. Mus., vol. 11, pp. 403-410.

CAUSEY, NELL B.

1942. Six new diplopods of the family Xystodesmidae. Ent. News, vol. 53, pp. 165-170, 9 figs.
 1943. A correction. Ent. News, vol. 54, p. 264.
 1950a. A collection of xystodesmid millipeds from Kentucky and Tennessee. Ent. News, vol. 61, pp. 5-8, 3 figs.
 1950b. On four new polydesmoid millipeds. Ent. News, vol. 61, pp. 193-198, 7 figs.
 1955. New records and descriptions of polydesmoid millipeds (order Polydesmida) from the eastern United States. Proc. Biol. Soc. Washington, vol. 68, pp. 21-30, 7 figs.

CHAMBERLIN, RALPH V.

- 1918a. Myriapods from Nashville, Tennessee. Psyche, vol. 25, pp. 23-30.
 1918b. New polydesmoid diplopods from Tennessee and Mississippi. Psyche, vol. 25, pp. 122-127.
 1939. Or some diplopods of the family Fontariidae. Bull. Univ. Utah, biol. ser., vol. 5, No. 3, pp. 1-19, 37 figs.
 1942. New southern millipeds. Bull. Univ. Utah, biol. ser., vol. 6, No. 8, pp. 1-19, 40 figs.
 1943. On some genera and species of American millipeds. Bull. Univ. Utah, biol. ser., vol. 8, No. 2, pp. 4-20, 38 figs.
 1947. Some records and descriptions of diplopods chiefly in the collection of the academy. Proc. Acad. Nat. Sci. Philadelphia, vol. 99, pp. 21-58, 73 figs.

CHAMBERLIN, RALPH V., AND HOFFMAN, RICHARD L.

1958. Checklist of the millipeds of North America. U. S. Nat. Mus. Bull. 212, 236 pp.

HOFFMAN, RICHARD L.

- 1948a. Two new genera of xystodesmid millipeds from eastern United States. Proc. Biol. Soc. Washington, vol. 61, pp. 93-96, 3 figs.
- 1948b. Three new eastern millipeds of the family Xystodesmidae. Journ. Washington Acad. Sci., vol. 38, pp. 346-350, 6 figs.
1949. Nine new xystodesmid millipeds from Virginia and West Virginia, with records of established species. Proc. U. S. Nat. Mus., vol. 99, pp. 371-389, 18 figs.
1950. Records and descriptions of diplopods from the southern Appalachians, Jour. Elisha Mitchell Sci. Soc., vol. 66, pp. 11-33, 32 figs.
1951. Subspecies of the milliped *Apheloria trimaculata* (Wood) (Polydesmida: Xystodesmidae). Nat. Hist. Misc., No. 81, pp. 1-6, 1 fig.
1955. Two additions to the amphibian fauna of Burkes Garden, Virginia. Amer. Midl. Nat., vol. 53, p. 256.

HOFFMAN, RICHARD L., AND KLEINPETER, HUBERT I.

1948. Amphibians from Burkes Garden, Virginia. Amer. Midl. Nat., vol. 39, pp. 602-607.

PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



issued by the
SMITHSONIAN INSTITUTION
U. S. NATIONAL MUSEUM

Vol. 109

Washington : 1959

No. 3412

MARINE MOLLUSCA OF POINT BARROW, ALASKA

By NETTIE MACGINITIE ¹

Introduction

The material upon which this study is based was collected by G. E. MacGinitie in the vicinity of Point Barrow, Alaska. His work on the invertebrates of the region (see G. E. MacGinitie, 1955) was sponsored by contracts (N6-ONR 243-16) between the Office of Naval Research and the California Institute of Technology (1948) and The Johns Hopkins University (1949-1950). The writer, who served as research associate under this project, spent the periods from July 10 to Oct. 10, 1948, and from June 1949 to August 1950 at the Arctic Research Laboratory, which is located at Point Barrow base at approximately long. 156°41' W. and lat. 71°20' N.

As the northernmost point in Alaska, and representing as it does a point about midway between the waters of northwest Greenland and the Kara Sea, where collections of polar fauna have been made, Point Barrow should be of particular interest to students of Arctic forms.

Although the dredge hauls made during the collection of these specimens number in the hundreds and, compared with most "expedition standards," would be called fairly intensive, the area of the ocean

¹ Kerckhoff Marine Laboratory, California Institute of Technology.

bottom touched by the dredge is actually small in comparison with the total area involved in the investigation. Such dredge hauls can yield nothing comparable to what can be obtained from a mudflat at low tide, for instance. The equipment available was incapable of penetrating the sticky mud to more than a few inches and dredge hauls are literally made in the dark. The results of such dredging cannot possibly compare with results obtained by digging in a mudflat where a practiced eye dictates. Nor can the dredging in the rubble zone compare with collecting along a rubble beach or rocky shore at low tide. Equipment could not bring up large rocks and, as every collector knows, it is the underside of large rocks and the substratum under them that tend to be the most rewarding in rocky shore collecting. Nonetheless, despite the disadvantages of a small boat and unfavorable weather, over 110 species and at least 11 varieties of mollusks were collected.

PREVIOUS WORK

Members of the International Polar Expedition to Point Barrow, Alaska, 1881-1883 (see Ray, 1885), were stationed near Point Barrow for two years. Their main objective was meteorological work and they were not equipped for dredging operations. Dall (1885b) identified and listed the species of mollusks collected in the vicinity of Point Barrow by this expedition; these total 33 species, plus 2 varieties, over two-thirds of which were shells gathered from the beach. Dall (1919c), who also identified the mollusks collected by the Canadian Arctic Expedition west from Bathurst Inlet, lists 26 species and 3 varieties picked up from the beach in the vicinity of Point Barrow. Actually, this expedition did very little work north of Alaska and western Canada. Various ship captains and expedition leaders took dredge hauls at several points along the Alaskan coast—at Cape Lisburne, Cape Sabine, Point Franklin, and Icy Cape, for example—but no one attempted to make a study of any one particular area. In fact, the majority of the Alaskan work was done south of Bering Strait.

EXTENT AND CHARACTER OF THE AREA INVESTIGATED

The G. E. MacGinitie collection was made largely in an area extending offshore in a northwesterly direction from Point Barrow base, which is 6 miles southwest of Point Barrow. Only one station (16 miles offshore) was more than 12 miles from shore, and the majority of stations were less than 6 miles from shore. An open coast, weather conditions, and a small boat precluded making many dredge hauls beyond 6 miles from shore, and dredging stations did not cover an alongshore distance much in excess of 6 miles. Dredge hauls were also made at Eluitkak Pass, the entrance to Elson Lagoon, a long,

shallow, barren lagoon extending along the coast southeast of the Point.

The beach at Point Barrow base consists largely of fine gravel, with an occasional narrow strip of sand or admixture of sand and gravel. The gravel extends out to a depth of 10 to 20 feet. This gravel zone is succeeded by the mud zone of fine, blue, sticky mud, so tenacious that clam shells such as *Macoma* have to be scrubbed individually to free them of mud. A dredge haul from this zone cannot be washed by dragging the dredge behind the boat; the mud has to be worked over by hand for its contained specimens. At a depth of about 100 feet, the mud zone is replaced by the rubble zone in which the bottom may be covered by pebbles and stones from the size of a walnut to small boulders. The bottom in the rubble zone is rather spotty, for there may be areas of mud or of gravel much beyond the depth of 100 feet, or there may be admixtures of mud, gravel, and stones in about equal quantity or in any proportion. Mud areas in the rubble zone consist of mud that is much less sticky than that of the mud zone.

About 12.1 miles from shore G. E. MacGinitie (1955, p. 71) discovered a canyon about a quarter of a mile across, the bottom of which (at dredging station 32) was 741 feet deep. On the shoreward side of this canyon the floor of the ocean was at a depth of 438 feet and on the oceanward side it was 522 feet deep. The bottom of this canyon was covered with mud and a mass of worm tubes, largely of *Pista maculata*.

Stations in the rubble zone are subject to almost yearly change, brought about by the deposition of mud from eroding shores. When the ice goes out and remains far offshore as it did in the summers of 1949 and 1950, wind storms create high surf with consequently greater erosion alongshore than when floating ice remains near shore as it did during the entire summer of 1948. Floating ice tends to dampen the effect of wind on waves and surf.

The reader should bear in mind that there are no tidal zone animals at Point Barrow. Usually in October, ice begins to form alongshore and the ocean freezes over out to a distance of several miles and seldom breaks up and leaves before about July 20. The tide apparently does not exceed 6 inches, although there may be wind tides of 3 feet or more during storms. Hence, the only "shore collecting" consists of gathering any specimens that may be washed ashore during storms in summer and early autumn. During the summer of 1948, almost no animals were washed ashore.

Even in summer the molluskan species at Point Barrow seldom experience a temperature above freezing, for the freezing point of salt water is lower than 32° F.

DREDGING STATIONS

Table 1, below, is taken from G. E. MacGinitie (1955, pp. 62-63). Fifty-two of these stations were at depths of less than 225 feet and only six exceeded 400 feet. Stations 29 and 30-31 represent the shoreward and oceanward floors, respectively, bordering the submarine canyon mentioned above. Eluitkak Pass is a unique station in that although it is only 35 to 40 feet deep, it is covered with rubble and with mud and gravel admixed, and it supports a fauna found at other stations at depths of not less than 110 feet. The most striking difference between the fauna of Eluitkak Pass and that of rubble bottom stations at depths of 110 to 200 feet is the absence of echinoderms and chitons at the Pass, this absence no doubt being due to dilution by fresh water

TABLE 1.—Dredging stations

No.	Date	Depth in feet	Type of bottom and remarks
1	7-20-48	10	Gravel
1a	7-26-48	22	Mud
2	7-26-48	50	Mud
3	8- 2-48	30	Mud
4	8- 6-48	40	Stones, mud, gravel (Eluitkak Pass)
5	8- 9-48	10-20	Gravel (alongshore from base to village)
6	8-10-48	40	Stones, mud, gravel (Eluitkak Pass)
7	8-21-48	80	Gravel
8	8-21-48	100	Gravel, small stones
9	8-21-48	140	Small stones (up to 4 inches), gravel
10	8-23-48	150	Gravel, small stones
11	8-23-48	20	Mud
12	8-30-48	40	Eluitkak Pass
13	9- 2-48	40	Eluitkak Pass
14	9- 8-48	110	Incomplete haul; rough current and wind
15	9- 8-48	60	Mud (out from radio masts)
16	9- 8-48	15	Sandy (out from radio masts)
17	9- 9-48	80	Mud
18	9- 9-48	100	Mud
19	9- 9-48	110	Mud, gravel
20	9- 9-48	125	Stones (sea urchins, <i>Psolus</i> , sea anemones)
21	9-15-48	110	Stones, mud, gravel (<i>Psolus</i> , sea anemones)
22	9-15-48	120	Stones (<i>Psolus</i>)
23	9-15-48	130	Stones (sea anemones, <i>Psolus</i> , sea urchins)
24	9-16-48	110	Shells, pebbles, mud
25	8- 8-49	120	Gravel, stones (large), mud
26	8- 9-49	130	Stones, gravel
27	8- 9-49	420	Stones, gravel
28	8- 9-49	70	Mud
29	8-17-49	438	Stones
30-31	8-17-49	522	Stones (sea urchins)
32	8-17-49	741	Mud (worm tubes)
33	8-30-49	184	Stones, boulders (<i>Psolus</i> and sea urchins—many)
34	8-30-49	30	Mud
35	9- 1-49	328	Gravel (coarse), stones (few large)
36	9- 6-49	477	Rocks (few) (worm tubes)
37	9- 6-49	217	Stones, large perforated rocks
38	9- 8-49	246	Pebbles, gravel, mud

TABLE 1.—*Dredging stations—Continued*

No.	Date	Depth in feet	Type of bottom and remarks
39	9- 8-49	148	Mud
40	9- 8-49	10	Gravel, mud (alongshore)
41	10- 6-49	295	Rocks, stone, gravel (<i>Psolus</i>)
42	10- 6-49	216	Rocks, stones (<i>Psolus</i> and sea urchins)
43	10- 6-49	213	Gravel, mud
44	10-11-49	453	Rocks, stones, gravel (small amount) (<i>Psolus</i>)
45	10-11-49	341	Rocks (few), stones, gravel (sea urchins)
46	10-14-49	152	Stones, mud, rocks (few)
47	10-14-49	175	Gravel, stones (small) (sea urchins)
48	2-13-50	129.5	Mud (bottom sampler)
49	2-14-50	149	Mud, stones (small) (haul made by dog team)
50	2-18-50	162	Mud, gravel, stones, rocks (few small) (haul made by dog team)
51	3- 9-50	135	Mud (very sticky) (haul made by dog team)
52	3-18-50	185	Mud, gravel, stones (bottom sampler)
53	3-21-50	120-130	Mud (Small bottom sampler)
53a	4-11-50	170	Mud (bottom sampler) (off radio mast)
53b	4-11-50	175	Mud (bottom sampler) (off Browerville)
54	7-21-50	72	Mud
55	7-22-50	132	Mud, gravel, shell, stones
55a	7-22-50	134	Mud, gravel, shell, stones
56	7-22-50	141	Mud, gravel, shell, stones
57	8- 1-50	118	Mud, gravel, shell, stones
58	8- 1-50	122	Mud, gravel, shell, stones
59	8- 1-50	138	Mud, gravel, sand, shell, stones (few small)
60	8- 1-50	40	Mud, stones (Eluitkak Pass)
61	8- 5-50	204	Mud, stones, gravel
62	8- 5-50	151	Mud, gravel

and to the surging currents that sweep through the Pass, stirring up the mud.

During the winter of 1949-1950, sampling and dredging were carried on through the ice, the dredging powered by means of dog teams. (For details of methods, see G. E. MacGinitie, 1955, pp. 53-57.) The results obtained were somewhat disappointing in that storms in early autumn had desposited several inches of mud over the ocean floor out for a distance of an undetermined number of miles—farther than the solid ice extended, so that it was impossible to dredge in a rubble zone that had not been blanketed with mud (see stations 48-62 in table 1). Some of the mud-dwelling pelecypods transported to the rubble zone by the storms were able to become established in this blanket of mud.

Trapping stations, not included in the following table, were maintained throughout the winter. At depths of 7, 21, 37, 64, and 80 feet, holes through the ice were kept open and screen and wire-mesh traps, usually baited, were kept on the ocean floor and inspected at intervals. All of these trapping stations were on muddy bottom, with the 80-foot hole at a distance of 1.8 miles from shore.

THE PRESENT STUDY

The writer undertook the identification of the mollusks from Point Barrow unaware of the great amount of work and complex difficulties involved. The work was scarcely begun before it became evident that the identifications would be far from simple and that library research would be extremely important. The difficulties of identification are due partly to the extreme variability of the Arctic shells, which has resulted in descriptions of numerous forms and varieties as separate species. But perhaps the greatest difficulty derives from the fact that in all too many instances taxonomists working on western specimens described as new species ones that had previously been described from Europe or Greenland, perhaps assuming that Greenland and the islands north of eastern Canada form an effective geographical barrier in a roughly circular ocean and that the distance in the other direction is too great for migration. Within recent years almost no one in America has worked on Arctic mollusks and the early names have been passed along in the literature without rechecking. Distribution records will be changed considerably when specimens in various collections can be reexamined and when more detailed study can be made at the family or generic level.

Two other factors contributed toward making the work time consuming: the inaccessibility of comparative material and of literature.

1. With the exception of that of the U. S. National Museum, the collections examined by the writer have almost no shells from Arctic waters; and the collection in the U. S. National Museum has relatively few specimens from the European Arctic or even from the Canadian Arctic. (The writer would like to stress the need for an exchange of northern specimens between institutions in this country and European institutions. An exchange of specimens among institutions, not only between different countries but also between institutions within this country, would materially decrease the labors of future workers and, in the event of major disasters, would be good insurance against total loss of specimens of certain species. A picture may be worth a thousand words, but often the best of illustrations cannot convey the ideas that a single specimen would impart.)

2. In order to straighten out some of the taxonomic problems in which many of the species were involved, it was necessary to consult the original descriptions. An attempt was made to read all of the original descriptions but it was not always possible to do so. In several instances the original description is in a copy of a journal or publication available in this country only in the Library of Congress or perhaps one other institution in the East.

Establishing the exact date of publication was almost impossible in certain references. In the belief that the reader will be interested in the reason for changes in date or author, explanations for such changes have been included in the text or in footnotes and in some instances explanatory notes have been added in the bibliography. It is hoped that such explanations will save future workers hours of library research.

In a work such as the present paper, it would be impossible to give complete synonymies for all the species, for in many instances the complete synonymy covers several pages. For example, one species dealt with in this paper has been known under 12 generic and 15 specific names, with many combinations of these various generic and specific names. The objective, therefore, has been to include the reference for the original description and, if possible, a recent and accessible American publication² that contains an illustration, as well as one of the more recent European publications that contains an illustration. In addition, references in the synonymies may include some of the less well-known synonyms, those containing good discussions or good distribution records, and references to those species placed in synonymy by the present writer.

Perhaps nowhere in the world do shells consistently exhibit such marked and confusing variations as do the Arctic species. Among the gastropods the genera *Buccinum*, *Boreotrophon*, *Neptunea*, *Beringius*, and *Diaphana* and among the pelecypods *Musculus*, *Astarte*, and *Lioctyma* are particularly subject to variation. Because of these great variations, species of some of these genera are extremely difficult to identify and in order to resolve these problems it will be necessary to make intensive studies at the specific level.

The Leptonidae in this country need a complete revision, for many species have not been assigned to the proper genus. A lifetime of work would be inadequate to bring complete order to the taxonomic chaos existing in the Turridae of this country, and the Pyramidellidae and Rissoidae are likewise in need of intensive work. At present the situation in these families is such that in many instances it is impossible to assign a species to a genus. Consequently several species have been referred to "*Oenopota*" in this paper.

In many instances the existing knowledge of a species is insufficient to enable one to say whether a specimen represents a variety or merely a form of the species. And in very few instances is existing information sufficient to enable one to refer a specimen to a subspecies in the present explicit meaning of the term.

The present paper is merely a beginning and no one realizes better than the writer that there are many unresolved problems, but it is hoped that it will point out the need for further study—and it is consoling to know that even the mistakes will contribute toward that goal.

In order to save space, collection dates usually have been omitted and are included only when they have some special significance, such as in the listing of young stages or of mature eggs or in those instances

² In recognition of the value of good illustrations, references to popular and semipopular works have been made freely.

in which there are duplicate depths. In the table on dredging stations the reader may find the collection date opposite the depth.

Complete ecologic and natural history notes are difficult to make on a large number of species before positive identifications are available. Such notes as are available are included under the appropriate genera or species in the systematic section below. Egg capsules of the gastropods were turned over to Dr. Gunnar Thorson of Copenhagen for study and the results of his work are now ready for publication.

THE MOLLUSCAN FAUNA OF POINT BARROW

Table 2 summarizes the geographic distribution of the Point Barrow mollusks, as well as their distribution in depth at Point Barrow. It should be understood that both of these are subject to change pending reexamination of collections and more extensive dredging at Point Barrow.

Among the prosobranchs of the gastropods there are 20 families, comprising at least 35 genera and 70 species, plus at least 10 varieties. Ten of these families are represented by only one species. The largest families are the Turridae, with 5 or more genera and 13 species, and the Neptuneidae, with 6 genera and 11 species. The Lamellariidae and Trochidae are next, each with 3 genera and 11 species. The genus *Buccinum*, with 8 species, is by far the largest genus, the next largest being *Boreotrophon* with 4 species and *Trichotropis* with 3 species.

The identification of the Opisthobranchiata is still incomplete but this group is being studied by Dr. H. Lemche of Copenhagen. When his work is completed, several more eolids and dorids should be added to the above list.

At this point mention should no doubt be made of the mollusks taken through the ice in winter. Dredging stations 49-51 were outside the pressure ridge or point where the ice was grounded. One of the 5 living specimens of *Admete couthouyi* was taken at 162 feet, 2 of the 7 living *Oenopota harpa* were dredged at 149 and 162 feet, and 1 of the 5 living *Beringius stimpsoni* was dredged at 162 feet. One of the 2 living *Cylichna occulta* was taken through the ice at a depth of 33 feet.

It is of especial interest that more than half the living *Buccinum angulosum* collected were taken by traps: 1 of the 5 typical *B. angulosum* (at 64 feet), 12 of the 18 var. *normale* (at 37 feet), 13 of the 26 var. *subcostatum* (at 37 and 64 feet), and 13 of the 14 var. *transliratum* (at 37, 64, and 80 feet). Several other species of *Buccinum* were also taken with traps: 5 of 9 *B. polare* (at 64 and 80 feet), 2 of 10 *B. tenue* (at 64 and 80 feet), 1 of 40 *B. plectrum* (at 37 feet), and 1 of 50 *B. glaciale* (at 80 feet).

The two chitons were both fairly common and, with the exception of Eluitkak Pass, were taken at most stations that afforded suitable places for attachment.

The cephalopods are of interest in that both the squid (*Gonatus*) and the *Benthoctopus* are new to the Arctic and the *Cirroteuthis* is undoubtedly a new species.

The pelecypods are represented by 16 families,³ comprising 25 genera and 37 species, plus several varieties. The family Nuculanidae is represented by 2 genera with 6 species, the Mytilidae and Tellinidae each by 2 genera and 4 species, the Leptonidae by 3 genera and 3 species, and the Hiatellidae by 2 genera and 3 species. Five families are represented by only one species.

The collection contained 3 new species that have been described, plus 1 new name, and undoubtedly 4 new species that are still undescribed. One of the latter is the deep sea octopus and the other three belong to the Turridae, a family that is being worked on by a retired malacologist.

Of the 107 species and 11 varieties (exclusive of the new species) listed in the above table, 59 species and 7 varieties are new to Point Barrow, and of this number 36 species and 7 varieties are new to Arctic Alaska and 18 species and 4 varieties are new to Arctic America. Exclusive of the new species, only 4 are new to North America.

A total of 17 species (including the new ones) and 4 varieties have been reported only from the Arctic area of the eastern Pacific, 12 species and 1 variety only from the Arctic area of the western Atlantic. Only 4 species, typical *Buccinum angulosum*, *Margaritopsis? grosvenori*, *Raphitoma amoena?*, and *Nuculana arctica*, and 2 varieties, *B. angulosum* var. *normale* and var. *subcostatum*, have been reported only from the Arctic. The fact that fewer species have been reported only from the Arctic on the east coast of North America than on the west coast may be the result of more collecting on the east coast.

One could make a summary of the number of species taken from the various depths but it would have little value. Aside from the factor of a suitable substratum, the number of species taken at the various depths outlined above reflects fairly well the amount of dredging that was done. The depths between 110 and 184 feet yielded more species than any of the others, but these depths represent 29 dredging stations, whereas the depths between 204 and 295 feet represent only 5 stations, the depths of 328 and 341 feet only 2 stations, and those between 420 and 477 feet only 4 stations.

³ Nicol's (1955) analysis of the MacGinitie collection of pelecypods from Point Barrow was based on an incomplete and incompletely identified collection. The collection contains 4 families, 7 genera, and 8 species in addition to those listed by Nicol. The number of individuals in the genera listed was also based on an incomplete collection. The collection was made by G. E. MacGinitie, not by Mrs. MacGinitie as stated in the paper.

[illegible]

ACKNOWLEDGMENTS

In 1951 the Office of Naval Research assigned a portion of funds from contract N6-ONR 243-16 (see p. 59) for transportation to Washington for study at the U. S. National Museum, and in 1955 the Arctic Institute of North America provided transportation for further study. The division of biology of the California Institute of Technology defrayed part of the expenses of the photographic prints. The negatives were made by G. E. MacGinitie.

To staff members of the U. S. National Museum the writer is indebted for many courtesies and for the use of facilities for study: to Dr. Remington Kellogg, Dr. Waldo L. Schmitt, Dr. Fenner A. Chace, Jr., and especially to Dr. Harald A. Rehder, curator, Division of Mollusks, and to members of his staff. (Three months were spent at the Museum in 1951 and three weeks in 1955.) The writer is particularly indebted to Dr. A. Myra Keen of Stanford University, who has been a constant source of encouragement and help in many ways. During February 1952 she placed the facilities of the Stanford Collection at the disposal of the writer. A day each was spent at the Los Angeles County Museum and the California Academy of Sciences, where permission was granted to examine the mollusk collections. The collection of Mr. John Q. Burch of Los Angeles was also examined.

Dr. Gunnar Thorson of the Zoological Museum at Copenhagen has been particularly helpful and cooperative in sending or exchanging specimens for examination, in comparing specimens with European and Greenland forms, and, in some instances, searching the literature for an obscure or elusive reference.

Various individuals and librarians have been of help in looking up references to which the writer did not have access: Miss Margaret Irwin of the Scripps Institution of Oceanography, Dr. Ruth D. Turner of the Museum of Comparative Zoology, Dr. Allyn G. Smith of the California Academy of Sciences, and members of the science division of the reference department of the Library of Congress. Mrs. Dorothy Halmos, librarian at the Allan Hancock Foundation, has rendered great assistance; and permission to use the stacks of this excellent research library has been of inestimable help.

By her generosity in sharing transportation, Dr. Marian H. Pettibone saved the writer much valuable time during the period spent in Washington.

Other acknowledgments are made in the text.

Class GASTROPODA
Subclass STREPTONEURA
Order ASPIDOBANCHIA
Suborder DOCOGLOSSA
Family LEPETIDAE
Genus *Lepeta* Gray, 1847
Lepeta caeca (Müller, 1776)

PLATE 4, FIGURES 1, 1A

Patella caeca Müller, 1776, p. 237.

Lepeta caeca Jeffreys, 1865b, p. 252, pl. 5, fig. 6.—G. Sars, 1878, p. 123, pl. 20, figs. 17a, b.—Morris, 1947, p. 73, pl. 25, fig. 2; 1951, p. 106, pl. 25, fig. 2.

Lepeta alba Dall, 1870a, p. 145, pl. 15, figs. 3a-d.

?*Lepeta alba instabilis* Dall, 1870a, p. 145, pl. 15, fig. 6.

Lepeta caeca Odhner, 1912, pp. 12, 32, pl. 2, figs. 2-17.

Thirty-four specimens, eight of which were dead shells, were dredged from depths ranging between 125 and 477 feet, the majority coming from 217 feet (10 living specimens) and deeper. The shells range in length from 5.5 to 11.0 mm. The measurements of several shells are as follows: 10.3 long by 7.8 wide by 4.8 mm. high; 10.1 by 7.8 by 4.5 mm.; 10.0 by 7.6 by 4.8 mm.; 9.1 by 7.1 by 4.1 mm.; and 8.8 by 6.6 by 3.8 mm.

OTHER MATERIAL EXAMINED: Seventy specimens from Norway, Greenland, Labrador, Newfoundland, Green Bank in the Bay of Fundy, Frenchman's Bay, Maine, near Cape Gaspé, and the east end of Cabourg Island in Baffin Bay. About 25 specimens (all dead shells) from localities ranging from the Sea Horse Islands, Alaska, to Captain's Harbor in the Aleutians (lat. 55° N.).

DISCUSSION: These specimens correspond with those collected at Point Barrow. Three specimens from western Norway are a trifle flatter and in one the apex is somewhat nearer the center than usual, but these variations are within normal limits.

There has been a great deal of confusion regarding the northern species of *Lepeta*. In *L. caeca* the posterior slope is nearly always markedly convex, and the anterior slope is straight (pl. 4, fig. 1A) and never slightly concave as in *L. concentrica* and *L. caecoides*. The radiating lines of striae in *L. caeca* are granular, the granulation varying in coarseness. *L. caeca* is relatively higher than *L. concentrica* and *L. caecoides*. For example, a specimen of *L. caecoides* measuring 10.4 mm. long by 8.0 wide is 3.3 mm. high, and a specimen of *L. caeca*

measuring 10.1 mm. long by 7.8 wide is 4.5 mm. high. Practically all of the *Lepeta* under *L. concentrica* and *L. caecoides* from the Sea Horse Islands, Icy Cape, Plover Bay, and Indian Point are actually *L. caeca*, and the others are too worn to be assigned to any species with certainty.

Dall's type lot of *Lepeta alba*, 13 specimens from Plover Bay, are undoubtedly *L. caeca*; they are all worn shells in much too poor a condition to base a description of a new species. Other specimens under *L. alba* are so worn that identification cannot be certain; from the shape, some appear to be *L. caeca*, others may be *L. caecoides*, and perhaps some are *L. concentrica*, but without the apex and with all the sculpture worn away they cannot be identified. The types and cotypes of *L. alba instabilis* are all dead shells and so eroded that a description should not be based upon them.

DISTRIBUTION: *Lepeta caeca* has been reported from Jan-Mayen, Spitzbergen, Norway, Iceland, Greenland, and from the Canadian Archipelago to Newfoundland and Cape Cod (Thorson, 1944). It has been taken from Point Barrow west and south to Captain's Harbor in the Aleutians. The Alaskan localities are new.

Suborder RHIPIDOGLOSSA

Family FISSURELLIDAE

Genus *Puncturella* Lowe, 1827

Puncturella noachina (Linnaeus, 1771)

PLATE 2, FIGURE 5; PLATE 4, FIGURES 2, 7

Patella noachina Linnaeus, 1771, appendix, p. 551.

Puncturella noachina Jeffreys, 1865b, p. 257, pl. 6, fig. 2.—Odhner, 1912, pp. 13, 37, pl. 2, figs. 28–41.—Farfante, 1947, p. 138, pl. 60, figs. 1–3.

One living specimen of this species was collected at a depth of 184 feet. The shell is 6.5 mm. long by 4.9 wide by 3.3 high.

OTHER MATERIAL EXAMINED: Numerous specimens from the western Atlantic. About 17 specimens collected by Dall in Captain's Bay, Unalaska, the Chica Islands, and the Shumagins; about 86 specimens collected by W. J. Fisher at Kodiak Island; 1 specimen from Stephens Passage (near Juneau).

DISCUSSION: Farfante (1947) states that this species has been recorded from southern Indian Ocean, from the Sea of Okhotsk, from Korea, and from Japan, and suggests that these latter records should "be restudied to determine if they are *Puncturella noachina* or a closely allied species." I examined a lot of 20 *Puncturella* (USNM 227297) from Hakodate, Japan. These are not *P. noachina*. They have a longer aperture, a wider and less funnel-shaped septum; they lack

the props and the triangular depressions at the sides of the septum (see pl. 4, fig. 2); they lack the calloused ridges, the groove is less pronounced, and there are no rows of chalky-white marks.

DISTRIBUTION: In the eastern Atlantic from Franz Josef Land, in the Arctic Ocean south to Scotland and northern England and on the continent along the coast of Norway south to Spain. In the western Atlantic from Greenland and the Melville Peninsula, and from Hudson Bay south to Cape Cod (Farfante, 1947). Magellan Strait, Patagonia, and the Falkland Islands (Odhner, 1912).⁴ In the eastern Pacific from Point Barrow, the Aleutians, the Shumagins, and south of Juneau. This species is new to Arctic Alaska.

Family TROCHIDAE

Genus *Margarites* Gray, 1847

Margarites costalis (Gould, 1841, ex Lovén MS)

VARIETIES

PLATE 1, FIGURES 1-7

Margarita striata Broderip and Sowerby (not Leach, 1819), 1829, p. 371.

Turbo cinereus Couthouy (not Born, 1778), 1838, p. 99, pl. 3, fig. 9.

Margarita cinerea Gould, 1841, p. 252.—Odhner, 1912, pp. 17, 62, pl. 4, figs. 28-37; pl. 5, figs. 1-5.

Trochus costalis Gould (ex Lovén MS), 1841, p. 252.

Turbo corneus Kiener (not Linnaeus, 1758), 1847-1848, pl. 19, fig. 2 [text in 1873, by P. Fischer, vol. 22, p. 129].

Margarita sordida Hancock, 1846, p. 324 [as substitute for *M. striata* Broderip and Sowerby].

Margarita cinerea var. *grandis* Mörch, 1869, p. 19.—Odhner, 1912, p. 17, pl. 4, figs. 34-36.

Margarita cinerea var. *grandis* forma *multilirata* Odhner,⁵ 1912, pp. 65-67, pl. 4, fig. 33; pl. 5, figs. 1, 2.

Margarites sordida Dall, 1921, p. 178, pl. 17, figs. 11, 12.

Margarites costalis Rehder, 1937, p. 115.

Margarites cinerea Morris, 1951, p. 114, pl. 26, fig. 5.

At least 100 specimens—the majority of which were living—of varieties of this species were taken from 16 stations at depths ranging

⁴In a personal communication Dr. Odhner informs me that he made no personal examination of specimens from these regions but that they were reported by Strebel in 1907 and 1908 and that his specimens are stored in the Riksmuseum. The division of mollusks of the U. S. National Museum sent me for examination several specimens from the above regions that had been described under the names of *Rimula corica* d'Orbigny and *Puncturilla falklandica* A. Adams and later had been assigned to *P. noachina* by one conchologist. The type of *R. corica*, from Cape Horn, and another specimen from the west coast of Patagonia are definitely not *P. noachina*. *P. corica* has a different apex, the shell is higher and thinner and the apical slit is widest at a different point; there are no props and the calloused ridges are lacking. *P. falklandica* bears more resemblance to *P. noachina*, but in at least five specimens from western Patagonia the props are lacking and the septum is shorter than in *P. noachina*. Further study will be necessary to determine whether or not a few specimens from Magellan Strait actually are *P. noachina*.

⁵Odhner (1912) generously ascribes forma *multilirata* to Mörch (1869), but Mörch did not use "multilirata" as the name of a form, he merely used the word in describing some of the variations of the var. *grandis*. Consequently, the word had no standing as forma *multilirata* until Odhner described and illustrated it in 1912.

from 120 to 741 feet. The stations at 217, 341, 420, and 453 feet yielded 14, 31, 17, and 26, respectively. About 10 of the specimens from 341 feet range in size from 7.7 mm. high by 8.6 mm. in diameter to 10.2 by 11.8 mm.; the others range from the latter size up to 20 mm. in height. Two specimens from 477 feet measure 5.7 mm. high by 6.5 mm. in diameter and 10 mm. by 10.3 mm. Two from 453 feet are 20.4 by 19.7 mm. and 17.9 by 18.3 mm.; one from 184 feet is 20.4 by 18.8 mm., and one from 120 feet (Aug. 8, 1949) is 20.8 by 18.5 mm. The younger specimens are broader than high and the larger ones are higher than broad.

OTHER MATERIAL EXAMINED: Varieties of *M. costalis* from the mouth of the Mackenzie River, Peard Bay and vicinity, and "north of Bering Strait"; numerous specimens from Melville Island, Greenland, Labrador and Newfoundland listed under various names; and specimens of typical *M. costalis* from south of Bering Strait and from Greenland and Norway.

DISCUSSION: Typical specimens of *M. costalis* are characterized by 4 to 6 prominent spiral ridges or cords that lend an angular appearance to the whorls, they are angled at the periphery of the last whorl and the base is flattened; the axial folds or ribs of the apical whorls give the latter a nodulus appearance, and the spiral ridges are alternated with secondary threads or lirae. The Point Barrow specimens are not typical *M. costalis*; they belong rather to the variety *grandis* Mörch (pl. 1, fig. 1) and the larger forma *multilirata* Odhner (pl. 1, figs. 5, 7). In both of these forms the spiral ridges are more numerous, from 5 to 8; they are often uniformly spaced without alternating smaller spiral lirae and, when present, the alternating lirae are not very pronounced and number only from 1 to 4, perhaps 5, on the last whorl. The shell is not angled at the periphery of the last whorl and the base is rounded. In var. *grandis* the base may be without any spiral lirae, or there may be from 1 to 6, with perhaps 2 to 3 around the strong cord outlining the umbilicus and 2 or 3 more near the margin (pl. 1, fig. 2). In forma *multilirata*, the base may have from 6 to 12 spiral lirae or cords (pl. 1, fig. 7), all of which may be uniformly strong, or uniformly weak, or may vary in strength in the same shell. The number of basal lirae seems to have little or no relation to the size of the shell. In both var. *grandis* and forma *multilirata* the nodulous appearance of the apical whorls is much less pronounced than in typical *M. costalis*. In some specimens from Melville Island the cord outlining the umbilicus is very weak, and in some the incremental lines are crowded into raised groups at intervals, detracting from the silky appearance characteristic of shells of this species. In the Point Barrow specimens and in the other specimens examined from other northern localities, there

are all types of combinations of characters and all transitional forms of sculpture.

DISTRIBUTION: The variety *grandis* and forma *multilirata* are circumpolar. They have been reported from Greenland to the Gulf of St. Lawrence, and from the European Arctic. They have not been reported previously from Arctic Alaska.

Margarites avenosooki, new species

PLATE 1, FIGURE 8; PLATE 3, FIGURES 8, 9

Shell medium sized, somewhat depressed, with $5\frac{1}{2}$ rapidly expanding whorls, including about $1\frac{1}{2}$ nuclear whorls. External surface of shell a rosy, grayish white, becoming ashy on the spire and within the umbilicus. Interior of aperture pearly, with brilliant greenish and pinkish lines of light, the green bands in shallow grooves corresponding to the spiral cords and threads on the external surface and the pinkish bands to the interspaces. Widely umbilicate whorls visible within to the nucleus. Sculpture of about 8 primary spiral cords on last whorl, with from 1 to 2 secondary threads between the cords near the suture but only one between those near the base; about 7 cords on the penultimate whorl, with secondary threads between most of them; about 5 cords on the antepenultimate whorl, with no secondary threads between them; about 7 equally spaced steplike cords on the slightly convex ascending base; 3 smaller cords on the descending slope of the base at the beginning of the umbilicus; remainder of the funnellike umbilicus devoid of cords; 5 cords visible on the body whorl between the inner and outer lip of the aperture. Spiral cords crossed by silky incremental lines, resulting in an uneven wavy appearance and, in some places, especially on those cords nearest the sutures, in a slight beaded effect. Aperture large, subquadrately oblique. Lip thin and crenated by the spiral cords. Operculum thin, multispiral, straw-colored.

DIMENSIONS: Holotype: height, 8.9 mm.; diameter, 11.7 mm.; angle of spire, 96° .

TYPE LOCALITY: About 4 miles off Point Barrow base, Alaska. Depth, 217 feet. Bottom: stones, large perforated rocks. Collected by G. E. MacGinitie, Sept. 6, 1949.

REPOSITORIES: Holotype, U. S. National Museum, No. 606,374; paratype, No. 606,375 (diameter, 2.8 mm., from 341 feet). One paratype (height, 9.2 mm.; diameter, 11.3 mm., from 420 feet), Stanford Univ. Paleo., No. 8331.

OTHER LOCALITIES: Bering Sea (1 dead), Bering Strait (1 live, 2 dead), north of Bering Strait (1 live), collected by U. S. S. *Corwin*; Plover Bay (2 live), St. Lawrence Bay (1 live). All these specimens

are in the collection of the U. S. National Museum. Depths, when specified, from 10 to 30 fms.

REMARKS: The outer lip of the holotype is somewhat broken. Some specimens are entirely grayish white or ashen without any rosy tint but aside from this and the variability of the intercalary threads and the piling up of incremental lines into incipient axial sculpture, there is little variation in the specimens examined. This species is named in honor of Mr. Olaf Avenosook, an Eskimo who served G. E. MacGinitie as boatman during the summer of 1948.

Margarites frigidus Dall, 1919

PLATE 2, FIGURE 7; PLATE 3, FIGURE 7

Margarites frigidus Dall, 1919b, vol. 56, p. 357.

This species was dredged from depths of 120 to 741 feet. Fourteen individuals (mostly from 1.6 to 2.5 mm. in height, but a few up to 6.5 mm.) came from 741 feet; 21 (mostly from 1.7 to 2.3 mm., but up to 6.0 mm.) came from 477 feet; 4 (from 1.5 to 2.4 mm.) came from 453 feet; and 9 (ranging from 3.0 to 7.0 mm. in height) were found among foliaceous bryozoans at a depth of 120 feet on Sept. 15, 1948. The largest specimen, 7.0 mm. in height, came from 130 feet on Aug. 9, 1949. One or two specimens were found in hauls from other depths, but the majority were very small.

The ovaries of several of the larger specimens of *M. frigidus* taken from 741 feet were filled with large eggs (larger than those of *M. vahli*) encased in thick membranes. These large eggs indicate that the larvae of *M. frigidus* must hatch in the crawling stage, and it is even possible that the eggs are retained until they hatch.

OTHER MATERIAL EXAMINED: About 17 specimens, including the type, from Bering Strait and the Arctic Ocean.

DISCUSSION: In some specimens the umbilicus is entirely closed and in others it is a mere slit. The young of *M. frigidus* have a more open umbilicus than larger specimens and hence may be difficult to distinguish from the young of *M. vahli* of similar size. The similarity is especially marked if they are in alcohol or other fluid, for then the delicate, incised lines on the base near the umbilicus of *M. frigidus* are often invisible. However, if the shells are allowed to dry, *M. vahli* remains as glossy as ever and *M. frigidus* becomes duller, with a silky rather than a glossy surface.

DISTRIBUTION: The range of *M. frigidus* is from approximately long. 134° to 170° W. and lat. 57° to 71° N., or from the Admiralty Islands (near Juneau), Alaska, to Nunivak Island, Bering Sea, and north and east to Point Barrow. The latter is a new locality. In

several publications the type locality of *M. frigidus* is given as "north of Bering Strait." The type specimen is from the north end of Nunivak Island, which is 5° south of Bering Strait.

***Margarites vahli* (Möller 1842)**

PLATE 4, FIGURES 8, 9

Margarita vahli Möller, 1842a, p. 8; 1842b, p. 81.—Odhner, 1912, pp. 17, 67, pl. 3, figs. 35–40; pl. 6, figs. 6–7.

Approximately 25 specimens of this species were collected from depths ranging from 120 to 741 feet. The largest specimens (3.4 high by 3.8 mm. wide, and 4.3 by 4.7 mm.) came from 741 feet. The next largest (3.2 by 3.4 mm.) came from 477 feet and another of the same height came from 453 feet. The remaining specimens were small: 2 (1.5 by 1.8 mm.) from 420 feet; 1 (1.5 mm. high) from 453 feet; 5 (from 1.5 to 3.2 mm. high) from 175 feet; and 5 (from 1.8 to 2.8 mm. high) were found among a foliaceous bryozoan at 120 feet on Sept. 15, 1949.

The ovaries of two specimens (4.3 mm. and 3.0 mm. high, respectively) from 741 feet were well filled with large eggs. Judging from the large size of its eggs, it is probable that this species has a short pelagic larval development.

OTHER MATERIAL EXAMINED: Five specimens from Spitzbergen and eight from Greenland.

DISTRIBUTION: Parry Islands, Labrador, Greenland, Iceland, and Spitzbergen (Thorson, 1944). The discovery of this species at Point Barrow materially extends its range westward. It is new to Arctic Alaska.

Genus *Margaritopsis* Thiele, 1906

***Margaritopsis pribiloffensis* (Dall, 1919)**

PLATE 2, FIGURE 10; PLATE 8, FIGURE 1

Margarites pribiloffensis Dall, 1919b, p. 366.

Three living specimens and two worn shells were collected. The 2 shells (5.7 and 5.2 mm. wide, respectively) and 1 living individual (7.5 high by 7.4 mm. wide) came from 741 feet, and 1 living juvenile about 1.0 mm. wide and another about 3.6 mm. wide came from 477 feet. Both of these stations were characterized by muddy bottoms and masses of terebellid worm tubes.

OTHER MATERIAL EXAMINED: The type, from near the Pribilof Islands; one specimen from near Point Belcher, and another from Bernard Harbor, Northwest Territories.

DISTRIBUTION: As above. Point Barrow is a new locality.

Margaritopsis ? grosvenori (Dall, 1926)

PLATE 2, FIGURE 12; PLATE 4, FIGURES 4, 5; PLATE 8, FIGURE 2

Margarites grosvenori Dall, 1926, p. 59.

One live specimen (3.1 mm. in diameter) was taken at 152 feet, 1 dead shell (3.5 high by 3.6 mm. in diameter) at 175 feet, and a broken shell at 216 feet.

OTHER MATERIAL EXAMINED: The types, consisting of 2 large broken shells from northwest Greenland, 1 medium specimen from Ungsuak, Greenland, and 4 large ones and 1 juvenile from Cabourg Island, Baffin Bay.

DISCUSSION: The specimens from northwest Greenland have finer striae than the ones from Point Barrow (pl. 8, fig. 2), and the ones from Cabourg Island have still finer spiral striae, but the specimen from Ungsuak has striae as coarse as those from Point Barrow.

In his original description Dall speaks of "the inner lip nearly covering a narrow umbilical opening." Actually, the umbilical opening in the types is at least moderately open and although the inner lip does overhang the opening to a certain extent, it is so high above the opening that the "covering" effect is not pronounced (pl. 4, fig. 5). This characteristic applies to all the specimens I have seen. The Point Barrow specimens are limy in appearance rather than "translucent pearly white," but this is a common variation in Point Barrow shells, especially in dead specimens.

This species was described as a *Margarites* but, because it has spiral sculpture and lacks axial sculpture and is without a spiral cord outlining the umbilicus, I have, with reservations, placed it in *Margaritopsis*. The peritreme is entire.

DISTRIBUTION: The Point Barrow specimens extend the range of this species from Greenland and Baffin Bay westward to Arctic Alaska and the Pacific area of the Arctic.

Genus *Solariella* Wood, 1842*Solariella obscura* (Couthouy, 1838)

PLATE 1, FIGURE 9; PLATE 2, FIGURE 11

Turbo obscurus Couthouy, 1838, p. 100, pl. 3, fig. 12.*Solariella obscura* Odhner, 1912, pp. 18, 70, pl. 5, fig. 22; pl. 7, figs. 9-20.—Dall, 1921, p. 178, pl. 18, figs. 11, 12.—Abbott, 1954, p. 110, figs. 31f-g.

One living adult and 5 young and juvenile specimens were collected: 1 (6.6 high by 7.6 mm. wide) at 132 feet, 4 juveniles at 216 feet, and 1 young (2.4 mm. wide) at 453 feet.

OTHER MATERIAL EXAMINED: About 175 specimens from Labrador to Massachusetts and Rhode Island, over 30 specimens from the eastern Atlantic (Russia, Norway, and other localities, and 7 speci-

mens from the eastern Pacific (from Icy Cape through Bering Strait to the Pribilofs and Aleutians).

DISCUSSION: In some of the specimens the base of the last whorl is convex and in others it is nearly flat. The base may have visible spiral striae or may be smooth (pl. 2, fig. 11). The axial cords (pl. 1, fig. 9) are prominent in some and faint in others, especially in the last whorl. Sometimes these cords evanesce at the periphery and appear again on the base. There is great variation in the strength of the revolving cord or cords. In the adult specimen from Point Barrow there are two spiral cords on the whorls. The color is whitish gray. Several specimens from Maine have a rosy cast.

DISTRIBUTION: Parry Islands (Thorson, 1944), Labrador to Rhode Island, Greenland, Iceland, Jan Mayen, Spitzbergen, northern and southern Norway, Russia; Point Barrow to the Aleutians. Point Barrow is a new locality.

Family LIOTIIDAE

Genus *Molleria* Jeffreys, 1865

Molleria costulata (Möller, 1842)

PLATE 3, FIGURES 2-5

Margarita costulata Möller, 1842a, p. 10; 1842b, p. 81.

Molleria costulata G. Sars, 1878, pp. 127, 343, pl. 9, figs. 8a-c.—Odhner, 1912, pp. 19, 75, pl. 5, figs. 43-47.

Six living specimens were dredged: 3 at 453 feet, 1 at 477 feet, and 2 at 741 feet. The larger specimen from 741 feet had 2 foraminifers on it, one of them completely filling and covering the umbilical opening.

OTHER MATERIAL EXAMINED: About 30 specimens from such localities as the Shetlands, Ireland, Spitzbergen, Sweden, Norway, Iceland, Greenland, and Newfoundland.

DISCUSSION: This species is highly variable. To give some idea of this variation, the specimens from Point Barrow have been divided into three general forms:

Form 1. One specimen of about 2.75 whorls from 477 feet (pl. 3, fig. 4) and another of about 2.50 whorls from 453 feet (pl. 3, fig. 3). In both the nucleus is intact. The smaller is light tan in color, the larger dark tan to light brown. The axial sculpturing consists almost entirely of incremental lines. In each shell a beaded spiral cord outlines the umbilicus and terminates at the summit of the peritreme. In the larger, three other spiral cords disappear into the umbilicus and in the smaller there are two and the beginning of a third. In both specimens, just posterior to the outer spiral cord there are the beginnings of axial cords separated by shallow oval depressions. These

axial cords continue across the base to at least the second spiral cord (pl. 3, fig. 4).

Form 2. Typified by a shell of perhaps 3 whorls (nucleus eroded) from 741 feet (pl. 3, fig. 2). The periostracum of this shell is dark brown, appearing almost black when wet. The somewhat wavy and sometimes interrupted axial cords of the last whorl are intermediate between those of Form 1 and Form 3 and are twice as numerous as those in Form 3, hence are narrower and have narrower interspaces between. These cords are interrupted at the base by a beaded cord that surrounds the umbilicus and terminates about the middle of the summit of the peritreme. Two more beaded cords, and a short and inconspicuous third cord, disappear into the umbilicus. The post-nuclear whorl has coarser axial cords separated by somewhat wider interspaces than those of the last whorl. A younger specimen, also dark, from 741 feet, has about 2+ whorls and has only the coarse and more widely spaced axial sculpture on the postnuclear 1.5 whorls. This sculpture is interrupted at the base by the spiral cord and two more spiral cords disappear into the umbilicus. A third specimen, from 453 feet, is tan colored, has 2.5 whorls, and axial sculpturing and spiral cords like the smaller specimen above. The nucleus, of one whorl, is intact.

Form 3. One specimen (1.9 mm. in diameter) of 3+ whorls (nucleus eroded), light tan in color, from 453 feet (pl. 3, fig. 5). The axial cords are similar on all the postnuclear whorls; they are coarse, perhaps a trifle coarser than those of the postnuclear whorl of Form 2, and are separated by wider interspaces. The umbilicus is not outlined by a spiral cord, but three short, inconspicuous beaded cords disappear into it. The axial cords are not interrupted at the base, which is convex.

The specimens examined from other localities exhibit all of these variations and more. A specimen from Holsteinborg, Greenland, has prominent axial cords, another from Gothaab has coarse and fine ribs on the same shell. Three shells from Newfoundland have fine to very fine axial sculpturing—too fine to designate as “ribs.” Several specimens from Davis Strait also have fine axial sculpturing. In some shells from Spitzbergen there are no visible cords or threads around the umbilicus, in others there are faint threads and in others there are as many as four to seven. In some shells there is neither an angle at the base nor beading of the spiral cord or thread, in others there is no angle, the base is rounded, but the spiral cord is beaded.

The variations described above cannot be accounted for on the basis of depth nor on the type of bottom, for all three of the forms mentioned above from Point Barrow were found at 453 feet.

DISTRIBUTION: The Parry Islands and Newfoundland to Cape Cod (Thorson, 1944), Great Britain, Sweden, Norway, Iceland, Greenland. This species is new to Alaska. The Point Barrow specimens represent a westward extension of range from about long. 120° to 156° W.

Order CTENOBRANCHIA

Suborder PTENOGLOSSA

Family EPITONIIDAE

Genus *Epitonium* Röding, 1798

Epitonium greenlandicum (Perry, 1811)

PLATE 5, FIGURES 2, 3

Scalaria greenlandica G. Perry, 1811, appendix, pl. 28, fig. 8.

Epitonium groenlandicum Morris, 1951, p. 122, pl. 27, fig. 6.—Clench and Turner, 1952, p. 320, pl. 131, fig. 2; pl. 154, figs. 1–3.

Twenty specimens were collected at depths ranging from 110 to 522 feet but only four of these were living; the others were usually worn or broken and encrusted with barnacles and bryozoans. Two live specimens (38 and 39 mm. long) were taken at 152 feet, 1 (36 mm.) at 216 feet, and 1 (25.5 mm.) at 328 feet. The dead shells range between 11.5 and 59.0 mm. in length. Except for a narrow brownish border around the thin edge, the operculums of these specimens are jet black.

OTHER MATERIAL EXAMINED.—About 30 specimens from the Aleutians and from 15 miles north of Cape Prince of Wales.

DISTRIBUTION: Spitzbergen south to southern Norway, Godhavn, Greenland, south to Montauk Point. L. I. (Clench and Turner, 1952); coasts of Siberia and Alaska south to Wrangell and to northern Japan.

Suborder TAENIOGLOSSA

Family LACUNIDAE

Genus *Aquilonaria* Dall, 1887

Aquilonaria turneri Dall, 1887

PLATE 2, FIGURES 8, 9

Aquilonaria turneri Dall, 1887, p. 204, pl. 3, figs. 1–3.

Three live specimens and one shell of this rare species were taken 1 shell (7.9 high by 5.9 mm. wide) at 217 feet; 1 living specimen (6.3, by about 5.0 mm.) at 477 feet; 1 (4.0 by 3.5 mm.) at 453 feet; and 1 (14.3 by 10.2 mm.) at 151 feet.

DISCUSSION: In August 1882 L. M. Turner took 3 specimens of this species from the ooze filling the crevices of rocks at Labrador's reef, Ungava Bay, and in the summer of 1885 Captain Healy took

3 specimens from north of Bering Strait. Some of the data on the label of the latter became illegible, but it is known that Captain Healy did not dredge north or east of Icy Cape and always in less than 65 fathoms. The northern range of this species has, therefore, been considered as lat. 66° N. No other specimens of this species have been recorded since 1885.

DISTRIBUTION: Ungava Bay, and north of Bering Strait to Point Barrow. The specimens from Point Barrow extend the known range northward about 5.5 degrees of latitude and eastward at least 5.0 degrees of longitude in the Pacific area of the Arctic, and the range in depth at least 15 fathoms.

Lacunid sp.

Two larval lacunids were taken from 341 feet on Oct. 11, 1949. Since *Aquilonaria turneri* was the only lacunid taken from the area under investigation, these larvae probably belonged to this species. Unfortunately, both specimens were lost in transit.

Family RISSOIDAE

Genus *Cingula* Fleming, 1818

***Cingula castanea* Möller, 1842**

var. *alaskana* Dall

PLATE 17, FIGURES 8, 9

Rissoa castanea Möller, 1824b, p. 82.

Cingula castanea G. Sars, 1878, p. 174, pl. 10, figs. 1a-b.

Alvania castanea var. *alaskana* Dall, 1886, p. 307, pl. 4, fig. 9.

Thirteen specimens were dredged: 3 (about 1.7 mm.) from 175 feet; 1 (about 2.7 mm., and with about 5 whorls or less) from 184 feet; 2 (1 shell dissolved, the other about 1.4 mm., with about 3 whorls) from 216 feet; 1 (about 1.9 mm., with 3 whorls) from 328 feet; 2 (about 1.2 mm., with about 3 whorls or less) from 341 feet; 3 (from about 1.8 to 2.6 mm.; 2 with about 3 whorls, 1 with about 4.5 whorls) from 477 feet; and 1 (about 1.7 mm., with about 4 whorls or less) from 741 feet. (The number of whorls includes the nucleus, which is usually partially eroded away.)

DISCUSSION: These specimens have yellow operculums. The whorls of the shells from 184 and 741 feet and 2 from 477 feet are evenly rounded with flattened spiral bands, separated by narrow incised lines, beginning close to the sutures; the whorls of those from 175, 216, 328, and 341 feet, and of 1 from 477 feet, have a slight

shouldered slope and the spiral bands begin at the slight angle. There is some variation in the number of spiral bands and in the width of the incised line between them.

Dr. Thorson compared these specimens with Möller's types. He states that the structure of these shells is quite identical with those of the types, but that in the type of *C. castanea* the last whorl is somewhat broader and the shell is somewhat larger than the ones from Point Barrow. These differences seem to agree with Dall's description of the differences between typical *C. castanea* and his variety *alaskana* in which he states that the latter has the same number of whorls as the typical form but is only five-eighths the length of typical *C. castanea*, and is much thinner than typical *C. castanea* generally is. Dall also says that in var. *alaskana* the wrinkles extending forward from the sutures are more prominent than in typical *C. castanea*.

The specimen from 184 feet, taken on Aug. 30, 1949, has at least 13 large eggs or embryos on its body, indicating that it is an ovoviparous species.

DISTRIBUTION: Point Barrow; and (Thorson, 1944) Grinnell Land and Newfoundland to Cape Cod, eastern and western Greenland; northern and eastern Iceland, Spitzbergen, and northern Norway. *C. castanea* has not been reported from the western Arctic.

Genus *Alvania* Risso, 1826

***Alvania jan-mayeni*? Friele, 1886**

Rissoa (Alvania) jan-mayeni Friele, 1886, p. 27, pl. 11, figs. 6, 7.

Alvania jan-mayeni Morris, 1947, p. 108, pl. 39, fig. 14; 1951, p. 145, pl. 39, fig. 14.

A single living specimen was collected at 741 feet on Aug. 17, 1949.

DISCUSSION: The shell, which was about 1.8 mm. long, was tan, with 2 reddish tan, beaded cords per whorl. The oval, yellow operculum consists of an acentric nucleus with two spirals. The shell, which was somewhat broken, subsequently dissolved, leaving the body and operculum of the animal.

Dr. Thorson, who examined the fragmentary shell, says that the color and the size and structure of the apex agree well with living specimens from eastern Greenland, but the condition of the shell renders positive identification impossible.

DISTRIBUTION: Point Barrow; and (Thorson, 1944) Newfoundland to Cape Cod, eastern and western Greenland; Jan Mayen, and Spitzbergen.

Family TURRITELLIDAE

Genus *Tachyrhynchus* Mörch, 1868*Tachyrhynchus reticulatum* (Mighels, 1841)

PLATE 5, FIGURE 9

Turitella reticulata Mighels, 1841, p. 50.—Mighels and Adams, 1842, p. 50, pl. 4, fig. 19.

A total of 7 living specimens and 3 shells was dredged: 1 living specimen (18.0 mm. high) from 184 feet; 1 (20.5 mm.) from 438 feet; 2 living specimens and 2 shells (from 6.7 to 22.3 mm.) from 477 feet; and 3 living specimens and 1 shell (from 10.2 to 17.4 mm. high) from 741 feet.

OTHER MATERIAL EXAMINED: About 45 specimens from localities ranging from the Sea Horse Islands to Plover Bay; about 250 from Captain's Bay, Unalaska Island and vicinity; about 60 from the Shumagins, Kodiak Island; 1 from British Columbia; and about 100 from localities from Labrador to Casco Bay, Maine.

DISCUSSION: In all of the Point Barrow specimens the spiral ridges are worn and the ribs are not prominent. The 45 specimens from north of Plover Bay are like the ones from Point Barrow in being worn and in having inconspicuous ribs and spiral ridges, but in specimens from Captain's Bay southward, both the spiral ridges and ribs are prominent. In a large lot from Captain's Harbor, the ribs and spiral ridges are so prominent that they give the shell a nodulous appearance. All of these latter shells are smaller than those from more northern waters. Even though worn, about one-half of the specimens from localities from Labrador to Maine have the stronger ribbing characteristic of those from the Aleutians. In a specimen from Greenland the ribs and spiral ridges are not prominent on the last whorls, and in another from Dolphin and Union Straits, although less worn than those from Point Barrow, the ribs and spiral ridges are not prominent.

In this species the spiral bands may be flat and broad with only a narrow groove separating them or they may be higher and narrower with a wider sulcus between. Axial ribs may be very prominent or rather insignificant as in the northern specimens.

Tachyrhynchus reticulatum is probably closest to *T. erosum* (Couthouy) but the former is more slender than *T. erosum* and the latter has no axial ribs (see Morris, 1951, pl. 31, fig. 16; 1952, pl. 26, fig. 9; and Abbott, 1954, pl. 21). The latter also has four or five low, narrow, rounded spiral striae on the base of the last whorl.

DISTRIBUTION: Greenland, Labrador, and Nova Scotia to Casco Bay, Maine; Point Barrow and west and south to Bering Sea and east and south to the Aleutians and British Columbia.

Family TRIPHORIDAE

Genus *Triphora* Blainville, 1828*Triphora perversa* (Linnaeus, 1758)

PLATE 3, FIGURE 6

Trochus perversus Linnaeus, 1758, p. 760.*?Cerithium perversum* Bruguière, 1792, p. 496.

One immature specimen was dredged at 341 feet. Including the nucleus, it has 8 whorls and is 2.5 mm. long by 1.3 mm. in diameter; it is reddish brown in color, with lighter nodules.

OTHER MATERIAL EXAMINED: About 55 specimens from the British Isles, 2 from Norway, and 13 from Tangier Bay, Sicily, and the Aegean.

DISCUSSION: This species is new to Arctic waters. The only other specimens collected north of the British Isles are those from Lofoten, Norway. Because of its small size and inconspicuous coloring, it has doubtless been overlooked in collections.

DISTRIBUTION: Point Barrow, Alaska; Dr. Thorson (personal communication) gives the Atlantic range as coast of Norway from Lofoten south, western Sweden, Denmark, the Shetlands, Orkney Islands, Great Britain, Ireland, coast of Europe to Madeira and the Canary Islands; also covers the Mediterranean.

Family CREPIDULIDAE

Genus *Crepidula* Lamarck, 1799*Crepidula grandis* Middendorff, 1849

PLATE 1, FIGURE 11; PLATE 5, FIGURE 7

Crepidula grandis Middendorff, 1849b, p. 18; 1849c, p. 101, pl. 11, figs. 8-10; 1849d, p. 429, pl. 11, figs. 8-10.—Kira, 1954, p. 28, pl. 14, fig. 3.

Fourteen live specimens and 2 shells were collected at depths of 120 to 453 feet. In August 1949 one live specimen with a shell 10 mm. long was washed ashore during a storm. Its shell was covered with the soft, encrusting bryozoan *Acyonidium polyomm* (Hassall). This species is ordinarily attached to rocks but one specimen 6.5 mm. long was found among a foliaceous bryozoan at 120 feet (Sept. 15, 1948). Although *C. grandis* is the largest *Crepidula* known, the ones from Point Barrow were small, ranging from 4.7 to 32.0 mm. in length, only three exceeding 20.0 mm.

OTHER MATERIAL EXAMINED: One dead shell from Icy Cape, 2 from Point Franklin, 1 small living one from "north of Bering Strait," and about 100 specimens from Kamchatka, Plover Bay, the Pribilofs, and other localities south and east to Sitka, Alaska.

DISCUSSION: The shell is white, both inside and out, and older specimens become rough and coarse. It is covered by a tan periostracum that is usually worn off in a large area around the apex and is often folded and overlapped around the periphery. There are variations in the relation of height to width: some are high and narrow, others flat and wide, with all gradations between.

DISTRIBUTION: Point Barrow, south and east to Sitka. Also Kamchatka. It is new to Point Barrow.

Family TRICHOTROPIDAE

Genus *Trichotropis* Broderip and Sowerby, 1829

Trichotropis bicarinata (Sowerby, 1825)

Turbo bicarinatus Sowerby, 1825, appendix, p. 12.—Broderip and Sowerby, 1829, p. 374, *Turbo*, pl. 9, figs. 4-8.

Trichotropis bicarinata Hirase, 1951, pl. 91, fig. 14.—Abbott, 1954, p. 168, pl. 24a.—Kira, 1954, p. 27, pl. 13, fig. 13.

Six living specimens and 3 dead shells were collected: 1 (10.8 mm. in diameter) from 130 feet; 2 dead shells (33.6 mm. and 37.5 mm.) from 420 feet; 2 (9.8 and 11.7 mm.) from 438 feet; 2 living (9.5 and 32.2 mm., and 1 dead (42.5 mm.) from 453 feet; and 1 living (4.8 mm. in diameter) from 477 feet.

OTHER MATERIAL EXAMINED: Numerous specimens from the Sea Horse Islands, Cape Sabine, Bering Strait, Plover Bay, St. Paul Island, Nunivak Island, and 2 large specimens from deep water off Nemuro, Yesso, Japan.

DISCUSSION: The specimens from Point Barrow present no great differences from the typical. There were none of Dall's variety *alta* (which is merely a more slender form), nor of his variety *spectabilis* (which has unusually prominent processes of periostracum extending from the keels).

DISTRIBUTION: Point Barrow south to Nunivak Island, and northern Japan; the east coast of North America. It has been reported from Greenland and Iceland, but Thorson (1944) does not list it. It has not been reported previously from north of Icy Cape in the Alaskan Arctic.

Trichotropis borealis Broderip and Sowerby, 1829

Trichotropis borealis Broderip and Sowerby, 1829, p. 375.—Morris, 1947, p. 117, pl. 39, fig. 17; 1951, p. 153, pl. 39, fig. 17; 1952, p. 103, pl. 26, fig. 10.—Abbott, 1954, p. 167, pl. 24d.

Only 2 specimens of this species were taken, both living: 1 (14.0 high by 10.3 mm. in diameter) from 130 feet (Sept. 15, 1948); and 1 (16.3 by 11.5 mm.) from 130 feet (Aug. 9, 1949).

OTHER MATERIAL EXAMINED: Numerous specimens from the British Isles, Norway, Iceland, Greenland, Labrador, Maine, and Massachusetts; also from Franklin Bay, Canada, and from localities from Bering Strait to the Queen Charlotte Islands, British Colombia; 4 specimens from Sakhalin Island.

DISCUSSION: There is variation in the degree of flaring of the outer lip, some shells are noticeably longer and narrower than others, and in some the last whorl enlarges much more abruptly than in others. There is also variation in the degree of "hairiness" or number and size of the "bristle-like appendages" of the periostracum. About half of the specimens from Sitka and farther south are relatively long and narrow, while those from Kodiak Island northward tend to be broader, with a more flaring mouth.

DISTRIBUTION: Spitzbergen, Norway, the Faroes, the British Isles, Iceland, Greenland; Parry Island, Melville Island (type locality), and Franklin Bay, Canada, and Labrador to Massachusetts; Point Barrow south and east to the Aleutians and the Queen Charlotte Islands. It is new to Point Barrow.

Trichotropis kroyeri Philippi, 1849

Trichotropis kroyeri Philippi, 1849, p. 175.—Dall, 1921, p. 149, pl. 11, fig. 1.—Oldroyd, 1927, pt. 3, p. 42; pt. 2, pl. 31, fig. 14.

Six specimens, five of which were empty shells, were dredged from 6 stations ranging from 80 to 477 feet. The smallest shell is 16.0 high by 11.5 mm. in diameter; the largest, 38.0 by 24.5 mm.; the living shell, 19.0 by 13.5 mm.

OTHER MATERIAL EXAMINED: Five specimens from Spitzbergen (type locality); about 50 from Point Barrow (1 dead shell, Ray Exped.), Cape Prince of Wales, the Shumagins, off Seniavine Island, off the Kudobin Islands, and off Bristol Bay.

DISCUSSION: There is considerable variation in the proportion of the length to the diameter; 3 specimens from off the Pribilof Islands and several from Spitzbergen are rather squat, and the latter have a distinct carina. In 4 specimens from Spitzbergen, the spiral cords are fewer and sharper and the shell is thinner than in the Alaskan specimens.

DISTRIBUTION: Spitzbergen (type locality); Point Barrow through Bering Strait to the Shumagins.

Family NATICIDAE

Egg "collars" of *Natica clausa* came up with the first dredge hauls made after the ice went out and were present throughout the summer and into the middle of October. One collar taken at 453 feet on Oct. 11, 1949, had one young snail in each egg space.

Egg collars of *Polinices* also appeared in dredge hauls from the first of the open season until the last of October. Not infrequently, collars and fragments of collars washed ashore. Most of the *Polinices* egg collars appeared much too large to belong to *P. monteronus* and *P. pallidus* of the sizes that were dredged, indicating that larger *P. pallidus* occurred farther offshore in deeper water or that some other larger species occurred there. Of 8 egg collars of *Polinices* that appeared in August, 3 were old and 5 were medium in age; of 11 taken on Sept. 26, 1949, 3 were old, 5 medium, and 3 were fairly fresh; of 5 taken on Oct. 3, 1949, 3 were freshly deposited and 2 were somewhat older; and one taken on October 28, 1949, had been deposited recently.

Larvae in egg collars deposited during the latter part of October undoubtedly spend the remainder of the winter developing and do not escape until early summer, but it is interesting to speculate on what happens to young naticids that are still in egg collars in the middle of October. It seems strange to think of them remaining in the egg collars until open water about nine months later, and equally strange to think of them spending their first months out of egg capsules during the depth of winter.

Genus *Natica* Scopoli, 1777

Natica clausa Broderip and Sowerby, 1829

PLATE 1, FIGURE 10; PLATE 12, FIGURE 8

Natica clausa Broderip and Sowerby, 1829, p. 372.—Odhner, 1913, pp. 7, 14, pl. 3, figs. 1-3, 5-14, 16, 17; pl. 5, figs. 7-14.—Dall, 1921, p. 163, pl. 14, fig. 11.—Oldroyd, 1927, pt. 3, p. 122, pl. 97, fig. 2.—Morris, 1947, p. 97, pl. 29, fig. 5; 1951, p. 133, pl. 29, fig. 5; 1952, p. 94, pl. 24, fig. 25.

Eluitkak Pass and practically every station deeper than 110 feet yielded from 1 to 5 specimens of *N. clausa*, and on three occasions during storms living specimens were cast ashore. Fourteen living specimens were taken from 213 feet and 11 from 453 feet. The largest shell (about 27 mm. in height) came from 213 feet; the smallest (7.0 mm.) from 162 feet; another small one (8.7 mm.) from 295 feet; another (7.9 mm.) from 213 feet; and still another (7.7 mm.) from 110 feet (September 8, 1948).

OTHER MATERIAL EXAMINED: Over 40 specimens from Novaya Zemlya, the Kola Peninsula, Spitzbergen, Norway, the Shetlands; several from off Labrador, Greenland, and the coast of Maine; about 40 from localities from Point Barrow to the Pribilofs, the Aleutians, Kamchatka, Sakhalin Island, and Japan.

DISCUSSION: The nucleus and at least the first postnuclear whorl of the Point Barrow specimens are badly eroded in even the youngest. There is variation in the length of the spire, in the degree of convexity of the whorls, in the degree of flattening at the suture, in the thick-

ness of the shell, and in the color, which ranges from pale olive-straw to brown. Many of the shells show scars where they have been repaired after being crushed; and many are pitted from the inroads of other animals.

DISTRIBUTION: Circumpolar.

Genus *Polinices* Montfort, 1810

Polinices pallidus (Broderip and Sowerby, 1829)

PLATE 12, FIGURE 10

Natica pallida Broderip and Sowerby, 1829, p. 372.

Lunatia pallida Odhner, 1913, pp. 8, 31, pl. 3, figs. 15, 19–37; pl. 4, figs. 1–8; pl. 5, figs. 16–18.

Polinices pallida Dall, 1921, p. 165, pl. 14, fig. 5.—Oldroyd, 1927, pt. 3, p. 126, pl. 97, fig. 9.

Ten specimens were taken: 1 living (9.4 mm. in diameter) from 120 feet (Aug. 8, 1949); 1 dead (26.4 mm.) from 130 feet (Sept. 15, 1948); 2 living (8 mm. and 13 mm.), from 162 feet; 1 living (17.5 mm.) from 341 feet; 2 living (about 13 mm., each) from 477 feet; 2 living (14 mm. and 17 mm.) from 741 feet; and 1 dead (19 mm.) from Eluitkak Pass. Tiny barnacles nestle in the sutures and in the pitted areas of even the living shells.

OTHER MATERIAL EXAMINED: Numerous specimens from localities ranging from the Sea Horse Islands south and east to the Aleutians and Puget Sound.

DISCUSSION: Even in the living shells from Point Barrow, and from such Arctic localities as Icy Cape, the periostracum and part of the shell structure are eroded over the nucleus and postnuclear whorls, and in one the body whorl is pitted and eroded. There is considerable variation in the height of the spire, in the suture, and in the degree to which the umbilicus is open; and one shell may be nearly twice as heavy as another of comparable size. The color ranges from a light olive-gray or a ripe straw to light and medium brown.

DISTRIBUTION: Northern and southern Norway, Spitzbergen, Jan Mayen, Iceland, Greenland; Melville Island south to Labrador and Cape Cod; Point Barrow south and east to the Aleutians and west to the Sea of Okhotsk, south to Puget Sound; and in deep water off Redondo Beach, Calif.

Polinices monteronus (Dall, 1919)

PLATE 12, FIGURE 9

Euspira monterona Dall, 1919b, p. 352.

Polinices monterona Dall, 1921, p. 164.

Eight living specimens were collected: 1 at 125 feet, 1 at 175 feet, 1 at 184 feet, 1 at 295 feet, 1 at 420 feet, 2 at 522 feet, and 2 at 741 feet.

The largest shell is 19.3 mm. in diameter, the smallest about 13.5 mm. Two empty shells were also taken.

OTHER MATERIAL EXAMINED: The type, from Captain's Harbor, Unalaska Island, in the Aleutians; and about 10 specimens from the following localities: Kotzebue Sound, near the Pribilofs, Amchitka Island in the Aleutians, and southeast of the Alaska Peninsula.

DISCUSSION: Time did not permit a thorough study of other northern species of *Polinices*, but it is obvious that *P. grönlandicus* and *P. pallidus*, especially the young, have been confused with *P. monteronus*. In most specimens of the latter, the umbilicus is almost or completely closed by the callus and the enamel of the inner lip, but in others the umbilicus is scarcely concealed at all. In some young specimens of *P. pallidus* the umbilicus is partially covered with enamel in such a manner that it closely resembles the notched callus of specimens of *P. monteronus* with the more open umbilicus. When a specimen of *P. pallidus* with this type of callus also has an unusually short spire, it is easily confused with *P. monteronus*. In such instances, the greatly thickened pillar lip of *P. monteronus* is diagnostic, for it is about twice as broad as that of *P. pallidus* (see pl. 12, figs. 9, 10). As in the preceding species, the nucleus and the postnuclear whorl are nearly always eroded.

DISTRIBUTION: Point Barrow south to Amchitka Island (about lat. 52° N.) in the Aleutians, and east and north to Prince William Sound.* It has not been reported previously from north of Kotzebue Sound.

Family LAMELLARIIDAE

Genus *Onchidiopsis* Bergh, 1853

Onchidiopsis glacialis (M. Sars, 1851)

Lamellaria glacialis M. Sars, 1851, p. 185.

Onchidiopsis glacialis G. Sars, 1878, p. 153, pl. 12, figs. 6a-c.—Odhner, 1913, p. 73, pl. 2, figs. 17, 18, 23, 24; pl. 5, figs. 3, 5, 32, 33.

In the open season of 1949, 15 specimens washed ashore: 2 in July, 3 in August, and 10 in September. One was dredged at 420 feet in August, and another at 453 feet in October. The largest of these, washed ashore in July, measured, when crawling, 34 mm. long, and the foot extended posteriorly beyond the body an additional 10 mm. The tentacles were 11 mm. long, the siphon 7 mm. long, and the largest tubercles were about 5.5 mm. high. When preserved, this same animal measured about 29 mm. long, 18 mm. wide, and 13.5 mm. high. After preservation, the smallest specimen, dredged in October, measured 18 by 12 by 10 mm. The shell from a somewhat contracted

* For more detailed locality records for many of the West Coast species, the reader is referred to Burch (1945-1946).

specimen that measured 28 mm. long, 18 mm. wide, and 14 mm. high is 17 mm. long and 12 mm. wide.

In life, the general color of these animals was tan to brown on a dusky white background. Fine, chalk-white dots were scattered over the background, and there was an occasional larger, pale lemon dot that looked like an aggregation of small dots. Fine lines of brown extended up the tubercles along the ridges. There were ridges and convolutions around the outer edge of the foot, and in each groove there was a fine line of tan.

DISTRIBUTION: The Kara Sea, Novaya Zemlya, the Murman Coast, Finmarken, Spitzbergen, Hope Island, Bear Island, Iceland, and Greenland (Thorson, 1944). It is new to North America and the Pacific area of the Arctic.

***Onchidiopsis groenlandica* Bergh, 1853**

VARIETY

Onchidiopsis groenlandica Bergh, 1853, p. 346, pl. 2.—Odhner, 1913, pp. 12, 74, pl. 2, figs. 19, 25; pl. 5, figs. 1, 6.

Onchidiopsis groenlandica Bergh var. *pacifica* Bergh, 1887, p. 278, pl. X, figs. 18, 22; pl. Y, fig. 19; pl. Z, fig. 23.—Odhner, 1913, p. 75.

A single specimen of what apparently belonged to this species was washed ashore in July 1948, but it was subsequently lost. The entire notaeum was bright orange and much smoother than that of *O. glacialis*. In its semicontracted state, the animal was about 27 mm. long.

DISTRIBUTION: Odhner (1913) gives the distribution as follows: Spitzbergen, Norwegian Islands, in the stomachs of cod; western Greenland, Grinnell Land, Iceland; and the var. *pacifica* Bergh from Kyska Harbor in the Aleutians. It is new to the Alaskan Arctic

Genus *Piliscus* Lovén, 1859

***Piliscus commodus* (Middendorff, 1851)**

PLATE 5, FIGURES 4-6

Pilidium commodum Middendorff, 1849d, p. 427 (no description); 1851, p. 214, pl. 17, figs. 4-11.

Pilidium radiatum G. Sars, 1878, p. 144, pl. 8, figs. 6a-d.

Eighty-five specimens, with shells ranging from 5 to 26 mm. in length, were collected. One washed ashore during a storm in September 1949, and seven during a storm in August 1950; the snails were still intact in their shells but most of them had died from exposure on shore and several of the shells were broken. One was dredged at Eluitkak Pass (40 feet), where the bottom is stony. The remaining 76 specimens were dredged at depths ranging from 120 (1 specimen) to 453 feet. The greatest number, 43, from any one haul was secured

at 175 feet; 2 of these are 5.5 mm., 1 is 18 mm., and the others average 12.2 mm. in length. Nine specimens (from 5 to 17 mm.) came from 453 feet; 6 (from 9 to 20 mm.) from 341 feet; and 6 (from 11 to 18.5 mm.) from 216 feet.

OTHER MATERIAL EXAMINED: Specimens from the Sea Horse Islands, Nunivak Island, St. Paul Island, and the Sea of Okhotsk.

DISCUSSION: The shells are covered with a yellowish periostracum that is worn away only in a small area at the apex. With the exception of 5 specimens, all of the Point Barrow shells of this species are white inside; the insides of the 5 specimens are marked with radiating lavender rays (pl. 5, fig. 5). Of the specimens examined from other localities, only 3 are from north of the 60th parallel: 1 from the Sea Horse Islands, 1 from "north of Bering Strait," and 1 from the "Arctic Ocean." Nearly all of the specimens examined from south of Bering Strait are characterized by the radiating lavender rays on the inside and even in some of the specimens that appeared white the rays could be detected by holding the shell to the light.

DISTRIBUTION: This species ranges from Point Barrow to the Pribilofs, Bering Sea, and the Sea of Okhotsk. Johnson (1934) and LaRoque (1953) give the Atlantic range as "off Nova Scotia in 150 fathoms."

Genus *Velutina* Fleming, 1820

Velutina undata Brown, 1839

And var. *zonata* Gould, 1841

PLATE 6, FIGURES 1-3

Velutina undata Brown ¹ in Smith, 1839, p. 102, pl. 1, fig. 15.—Brown, 1849, p.

255.—Odhner, 1913, pp. 11, 55, pl. 2, figs. 1-10, 15; pl. 5, figs. 27, 28.

Velutina zonata Gould, 1841, p. 242, fig. 160.

Morvillia undata G. Sars, 1878, p. 147, pl. 21, figs. 7a-b.

Six specimens were collected: 2 shells (23 mm. and 27.5 mm. long) from Eluitkak Pass on Aug. 10, 1948; 1 shell (10 mm.) from 204 feet; 1 living specimen (4.5 mm.) from 217 feet; 2 specimens (8 mm. and 19.6 mm.) from 453 feet; and 1 living specimen (15 mm.) from 741 feet.

OTHER MATERIAL EXAMINED: One specimen from Lofoten Island, Norway; 2 from Spitzbergen; about 55 from localities from Murray Bay, Quebec, to Eastport, Maine; over 20 from localities from Icy Cape to the Kudobin Islands.

¹ European authors list this species as "*Velutina undata* Brown, 1838," and Sherborn (1932) as "*Velutina undata* Smith, 1839." The latter date is correct, but the description should be credited to Brown. On page 102 of Smith (1839) a heading for the description of this species appears as "*Velutina undata*, n. s.—Smith," but the end of the description on page 103 is followed by "—B." In a footnote on page 98, Smith states "The descriptions marked B, I owe to Mr. T. Brown, and those marked F, to Mr. Edward Forbes." In view of the heading to the description, it is small wonder that Sherborn credited the description to Smith.

DISCUSSION: This is the shell that has commonly been called *V. zonata* Gould by West Coast workers. The 2 specimens from 453 feet are typical forms; the one from 217 feet is probably var. *zonata* Gould. In typical *V. undata* the inner lip is broader and more excavated than in var. *zonata* and the outer lip is expanded and extends above the spire; in var. *zonata* the outer lip is not expanded and does not rise beyond the apex. In the Point Barrow specimens the calcified inner layer varies from chalky white to bluish white and the cuticulum varies from a dull tan to pale brown.

DISTRIBUTION: Circumpolar; Siberian, Russian, Norwegian, Canadian, and Alaskan Arctic; Scotland, the Faroes, Iceland, Greenland, south to Maine; Point Barrow south to the Kudobin Islands. A questionable record from Monterey Bay. It is new to Point Barrow.

Velutina velutina (Müller, 1776)

And var. *schneideri* Friele

PLATE 6, FIGURES 4, 5

Bulla velutina Müller, 1776, p. 242.

Velutina laevigata G. Sars, 1878, p. 146.—Oldroyd, 1927, pt. 3, p. 140, pl. 92, fig. 8.—Abbott, 1954, p. 175, pl. 22n.

Velutina schneideri Friele, 1886, p. 26, pl. 11, figs. 3, 4.

Velutina velutina Odhner, 1913, pp. 11, 60, pl. 1, figs. 17-26; pl. 5, figs. 22, 24.

Possibly 4 specimens were collected: 1 (8 mm.) from 453 feet; 1 (14.5 mm.) from 741 feet; and 2 small, living specimens (4 mm. and 2.75 mm.) from 453 feet and 420 feet, respectively, probably belong to this species.

OTHER MATERIAL EXAMINED: About 100 specimens from Norway, Spitzbergen, Shetland, Scotland, and Greenland; about 25 from localities from Newfoundland to Massachusetts; about 15 from localities from Icy Cape to Kodiak Island, and Puget Sound.

DISCUSSION: This is the species commonly referred to as *V. laevigata* Linnaeus by West Coast workers. The Point Barrow specimens are white within and have a thin, horn-colored periostracum. The largest specimen, from 741 feet, has a smoother periostracum, characteristic of the var. *schneideri* Friele, 1886. The 8-mm. specimen from 453 feet is a typical *V. velutina*, in which the longitudinal ridges of the periostracum are distinct (see Odhner, 1913, pl. 1, figs. 17-23, 26; pl. 5, figs. 22, 24). In var. *schneideri* the calcareous layer is thin and the longitudinal cuticular ridges are indistinct or absent (see Odhner, 1913, pl. 1, figs. 24, 25; pl. 5, fig. 23).

This species has been reported from Monterey Bay and the coast of California. The California specimens that I examined are consistently small; they are higher and flare less than *V. velutina*; the striae of the periostracum are closer than in *V. velutina* and these

striae are closely beset with hairs; the shell is more heavily calcified than in *V. velutina*. Shells of *V. velutina* from Norway and Maine that are the same size as those from Monterey Bay look entirely different. The California specimens may be a new species.

DISTRIBUTION: The Siberian, Russian, and Norwegian Arctic; coast of Norway south to Portugal (rare); eastern Canada and Newfoundland south to Cape Hatteras (Thorson, 1944); Point Barrow, south through Bering Sea and east and south to Puget Sound; also Kamchatka. It is new to Point Barrow and this name is new to the Pacific.

***Velutina plicatilis* (Müller, 1776)**

And var. *cryptospira* Middendorff

PLATE 6, FIGURES 6, 8-10

Bulla plicatilis Müller, 1776, p. 242.

Helix coriacea Pallas, 1788, p. 243, pl. 7, figs. 31, 33.

Velutina cryptospira Middendorff, 1849b, p. 18; 1849d, p. 435; 1851, p. 216, pl. 25, figs. 8-10.

Velutina sitkensis A. Adams, 1851, p. 225.

Velutella cryptospira G. Sars, 1878, p. 149, pl. 21, figs. 9a-b.

Velutina plicatilis Odhner, 1913, pp. 12, 67, pl. 1, figs. 12-16; pl. 5, figs. 25, 26.

From Aug. 17 to Oct. 5, 1949, 9 specimens washed ashore; 1 washed ashore on July 26, 1950; 1, living (17 mm. long), was dredged at 10 feet on Sept. 8, 1949; 1 (11 mm.) at 175 feet; and 1 (12 mm.) at 741 feet. Even the majority of those that washed ashore were still living. The shells range in length from 17 to 26 mm.

OTHER MATERIAL EXAMINED: Over 30 specimens from localities from Icy Cape to the Pribilofs, the Aleutians, and the Shumagins; 1 from Halifax, Nova Scotia.

DISCUSSION: Most of the specimens from Point Barrow belong to the var. *cryptospira* Middendorff, which is the same as *V. sitkensis* A. Adams; but there are all intergradations between typical *V. plicatilis* in which the spire is fully visible and those specimens in which it is completely hidden (var. *cryptospira*). There has been much confusion regarding the species of *Velutina*, due largely to the great variations within a species. For example, *V. plicatilis* always has a calcareous incrustation in the innermost whorls, and sometimes the outer whorl has a thin calcareous lining, and since it often has spiral sculpture like that of *V. velutina*, well-calcified young of *V. plicatilis* with visible spires and spiral sculpture have sometimes been confused with *V. velutina*. Odhner (1913) gives excellent illustrations of several species of *Velutina* and summarizes the distinctions.

DISTRIBUTION: Spitzbergen, the White Sea, Norway, Belgium, the British Isles, Ireland, Greenland (Thorson, 1944); Halifax and

Newfoundland; Point Barrow south to the Pribilofs and the Aleutians. It has not been reported previously from Arctic Alaska.

Velutina lanigera Möller, 1842

PLATE 6, FIGURE 7

Velutina coriacea of authors (in part) (not *Helix coriacea* Pallas, 1788).

Velutina lanigera Möller, 1842a, p. 10; 1842b, p. 83.—G. Sars, 1878, p. 146, pl. 12, figs. 3a-b.—Odhner, 1913, pp. 11, 65, pl. 1, figs. 27-29.

One empty shell, over 31 mm. long, was washed ashore on Sept. 12, 1949.

OTHER MATERIAL EXAMINED: One specimen from Bering Sea; several from Petrel Bank, Bering Sea; several from Cape Lisburne; and others.

DISCUSSION: This species has been confused with *V. plicatilis* (= *V. coriacea* and *V. sitkensis*) and other species. The earliest whorls of *V. lanigera* are broader and more inflated than those of *V. velutina*, and in shells of the same size *V. velutina* has about one half more whorl than *V. lanigera*. The calcified layer is more reduced in *V. lanigera* than in *V. undata*. The entire shell is longer than that of *V. plicatilis*, it has a much larger spire, and the periostracum is thicker.

DISTRIBUTION: Northern and southern Norway, Spitzbergen, Iceland, western Greenland; Point Barrow south to Petrel Bank, Bering Sea. Careful study of specimens in the U. S. National Museum may extend the range farther south. This species has not been reported previously from North America.

Suborder RACHIGLOSSA

Family MURICIDAE

Genus *Boreotrophon* Fischer, 1884

The northern species of this genus are in need of a thorough study and revision. Gould (1870, p. 377-78) describes *Trophon clathratus* as a small, brownish, ventricose shell with 6 whorls and from 15 to 20 sharp varices. He considers this shell the same as *Trophon bamffius* of English authors. He describes *Trophon scalariformis* as a fusiform, white or reddish brown shell with 7 whorls and from 15 to 20 flexuous varices with jagged edges, usually more elevated at the posterior part of the whorls so as to produce an angular appearance. Bartsch (1921, p. 87) states that the European form is *T. clathratus* and the western Atlantic members are *T. scalariformis*. After examining some Point Barrow specimens identical with our western Atlantic *Boreotrophon scalariformis*, Dr. Gunnar Thorson informed me

that these shells are identical with what they call *B. clathratus* and that the smaller specimens sent him are *B. clathratus* var. *gunneri*. The latter are angulated and are undoubtedly the forms that Gould described as having varices more elevated at the posterior part of the whorls.

The number of varices is a highly variable character in the northern species of *Boreotrophon*. Some varices may be three times as far apart as others on the same whorl and still others may be so close together that they give the appearance of a double varix.

At Point Barrow 2 capsules, each containing 2 embryos, of a species of *Boreotrophon* were dredged at Eluitkak Pass on Aug. 30, 1948.

Boreotrophon clathratus (Linnaeus, 1767)

And vars. *gunneri* Lovén and *scalariformis* Gould

PLATE 7, FIGURES 1-7

Murex clathratus Linnaeus, 1767, ed. 12, p. 1223.

Murex multicostatus Eschscholtz, 1829, pt. 2, p. 11, pl. 9, fig. 4.

Fusus lamellatus Gray, 1839, p. 117, pl. 36, fig. 13.

Tritonium gunneri Lovén, 1846, p. 144.

Fusus scalariformis Gould, 1840, p. 197; 1841, p. 288, fig. 203.

Trophon clathratus G. Sars, 1878, p. 247, pl. 15, fig. 10 (= type).—Morris, 1947, p. 144, pl. 39, fig. 15; 1951, p. 184, pl. 39, fig. 15 (= var. *gunneri*).

Trophon clathratus var. *gunneri* G. Sars, 1878, p. 247, pl. 15, figs. 11, 11a.

Trophon scalariformis Bartsch, 1921, p. 87.—Morris, 1947, p. 144, pl. 39, fig. 11; 1951, p. 185, pl. 39, fig. 11.

Boreotrophon multicostatus Abbott, 1954, p. 207, fig. 46c (= var. *gunneri* Lovén).

Eighteen living and 3 dead specimens were dredged at depths of 110 to 741 feet. The depths of 125, 184, and 295 feet yielded 3 specimens each, and those of 110 (Sept. 15, 1948), 420, and 741 feet yielded two each. The 2 largest specimens are 39.5 mm. long; the smallest, 28 mm. Foraminifers and hydroids are common on these shells.

The var. *gunneri* Lovén is represented by 8 living and 5 dead specimens from depths of 80 to 741 feet, 4 of the living specimens coming from depths of 438 to 741 feet. The largest living specimen is 28.5 mm. long; the smallest, 18.5 mm. Foraminifers and hydroids are common on these shells also.

OTHER MATERIAL EXAMINED.—About 30 specimens of *B. clathratus* from St. Peter's Bank, the Grand Banks, and Newfoundland; 1 from Massachusetts Bay; about 15 from western Greenland; and 1 from Spitzbergen.

DISCUSSION.—There are variations in the length and arcuateness of the canal and in the degree to which it is reflected; there are from 15 to 19 varices in the Point Barrow specimens of *B. clathratus*. One speci-

men about 35 mm. long from 125 feet has a long, narrow canal, slightly reflexed, but not arcuate, suggesting a variety of *B. cepulus*. The specimen of var. *gunneri* from 438 feet also has a long canal, but it is arcuate and not so narrow as in the *B. clathratus* from 125 feet. In a specimen of var. *gunneri* from 125 feet there are only 9 or 10 varices, which extend outward markedly from the posterior end of the last whorl. In other specimens of var. *gunneri* from Point Barrow the varices number up to 15; there is great variation in the depth of the varices (which is reflected in the degree of angulation at the shoulder), in the length of the canal, and in the proportion of the length of the spire to the length of the aperture and canal.

DISTRIBUTION: Baffin Land to Cape Cod; Greenland; Iceland, the Hebrides, England, the Faroes, Norway, Spitzbergen, Novaya Zemlya, White Sea, Franz Joseph Land, the Siberian Arctic. Thorson (1944) also lists Bering Strait, Alaska, Puget Sound, and Japan, but none of our western literature mentions *B. clathratus* or even var. *scalariformis*. I believe that the Point Barrow specimens form the first published record of *B. clathratus* from Alaska and the Pacific area (although Gray's *Fusus lamellosus* (1839), which was from Icy Cape is undoubtedly *B. clathratus*). However, I also believe that careful study of specimens of *B. beringi*, and perhaps *B. pacificus*, in the U. S. National Museum will reveal specimens of *B. clathratus* and var. *gunneri* taken from south of Bering Strait.

Boreotrophon beringi (Dall, 1902)

PLATE 7, FIGURES 11, 12

Trophon beringi Dall, 1902, p. 544; 1921, p. 109, pl. 10, fig. 6.—Oldroyd, 1927, pt. 2, pl. 30, fig. 6; pt. 1, pl. 18, fig. 8.

Seventeen living and 7 dead specimens were collected: 3 living and 2 dead specimens washed ashore in September 1949; 1 dead specimen came from 110 feet; the remainder were dredged from 11 stations from 120 (Aug. 8, 1949) to 741 feet, with 4 living coming from 175 feet. The entire spire and part of the last whorl of a specimen from 162 feet were covered with a species of *Syncoryne*.

OTHER MATERIAL EXAMINED: Numerous specimens from localities from Icy Cape through Bering Strait to the Pribilofs, the Aleutians, the Shumagins, Cook's Inlet, and 1 from Puget Sound (see below); also from Kamchatka.

DISCUSSION: In the specimens from Point Barrow the varices vary from 17 to 25, the majority of the shells having from 19 to 21. This species has a wider canal than *B. clathratus*, a more tumid body whorl, and the varices do not project so far. Out of 117 specimens examined in the collection of the U. S. National Museum, only 22 have 12 varices

or less, 65 have from 13 to 16, and 30 have from 17 to 23. Thus it is obvious that relatively few have the small number of varices (9 to 12) given in the original and subsequent description. (The specimen from Puget Sound does not look like *B. beringi*.)

DISTRIBUTION: From Point Barrow through Bering Strait to the Aleutians and Puget Sound (?). Point Barrow is a new locality.

Boreotrophon pacificus (Dall, 1902)

PLATE 7, FIGURES 13, 14

Trophon pacifica Dall, 1902, p. 544; 1921, p. 110, pl. 11, fig. 5.

Trophon pacificus Oldroyd, 1927, pt. 2, p. 35, pl. 30, fig. 4.

Boreotrophon pacificus Abbott, 1954, p. 208, fig. 46f.

Two living and 19 dead specimens were collected: 11 empty shells washed ashore during August and September 1949 and the remaining 8 empty shells were taken from depths of 80 to 741 feet; the 2 living specimens came from 217 and 741 feet. The one from 217 feet was practically covered with the hydroid *Syncoryne*.

OTHER MATERIAL EXAMINED: Numerous specimens from the Aleutians, Kodiak Island, and Port Etches, Alaska.

DISCUSSION: I am not at all confident that I have in every instance been able to distinguish between specimens of *B. beringi* and *B. pacificus* (see also *B. truncatus*). Dall's distinction of more varices in *B. pacificus* than in *B. beringi* is of no value, for he selected for his type of *B. beringi* a specimen with few varices. The Point Barrow specimens of *B. pacificus* have from 15 to 24 varices, the majority having from 16 to 21, covering practically the same range as in *B. beringi*. Nor is the statement that *B. pacificus* "resembles *T. beringi* in miniature" very useful, for there are small specimens of *B. beringi*. I attempted separating these species on the basis of the nucleus and the length and shape of the canal. The nucleus of *B. beringi* seems to be larger and blunter than that of *B. pacificus*. The canal of *B. beringi* seems to be relatively longer and more arcuate than in *B. pacificus*, but a *B. beringi* with an unusually short canal or a *B. pacificus* with an injury that causes the canal to curve more than usual makes this distinction useless.

DISTRIBUTION: This species is said to occur from the Arctic Ocean southward through Bering Sea, the Aleutians, Kodiak Island, and Hinchinbrook Island; Kamchatka; and in deep water off California and Acapulco, Mexico (Dall, 1921, p. 110; Burch, 1945, vol. 2, pt. 1, No. 51, p. 58), but none of the collecting records is from north of Bering Strait. The specimens from Point Barrow, therefore, extend the range of *B. pacificus* into the Alaskan Arctic.

Boreotrophon truncatus (Strøm, 1768)

PLATE 7, FIGURES 8–10; PLATE 8, FIGURES 3, 4, 7, 9

Buccinum truncatum Strøm, 1768, vol. 4, p. 369, pl. 16, fig. 26.*Trophon truncatus* G. Sars, 1878, p. 246, pl. 15, fig. 9.—Morris, 1947, p. 144, pl. 39, fig. 1; 1951, p. 185, pl. 39, fig. 1.

Because of difficulties in identification, the exact number of specimens of this species is in question. Two living specimens (17.7 mm. long by 7.6 mm. in diameter, and 16.6 mm. by 7.8 mm.) were taken from 741 feet (pl. 8, figs. 4, 9). Six living specimens (ranging from 6.3 to 11 mm. in length) with from 4 to about 5.5 whorls, and with from 12 to 16 varices (the number not dependent on size of shell), were found among a foliaceous bryozoan from 120 feet (Sept. 15, 1948). The smallest of these was practically covered with a colony of encrusting bryozoans.

Also on this foliaceous bryozoan from 120 feet a *Boreotrophon* measuring 13.9 by 7.2 mm. with 5.5 whorls and with 18 varices was found. The spire of this shell was covered with old hydroid stalks among which were what appeared to be small, irregular, flattish packets of yellowish, oval eggs with a round hyaline dot toward one end. From 217 feet was dredged a similar live shell measuring 11.1 by 5.9 mm. with about 5.25 whorls and with 17 varices. The spire of this shell was covered with a growth of *Syncoryne* (pl. 8, fig. 3). Two living specimens, similar to the two just mentioned, were taken at 184 feet (pl. 8, fig. 7), 1 at 438 feet, and 2, somewhat larger, at 125 feet.

Ten other living specimens and 5 dead shells, all larger than the ones mentioned above, came from depths of 72 to 438 feet.

OTHER MATERIAL EXAMINED: Several specimens from the Jeffrey's collection (now in the U. S. National Museum); several in the collection of the U. S. National Museum; 4 from western Greenland (sent by Dr. Thorson).

DISCUSSION: The 4 specimens from Greenland have about 5.5 whorls and 18 varices; they are beige colored, with beige to dark tan throats. By comparison, the Point Barrow specimens are translucent white to chalky white and the throats are white. The smallest Point Barrow specimens mentioned above are slenderer (pl. 8, fig. 7) than the Greenland *B. truncatus*; the aperture seems a trifle smaller and the canal a little longer than in the Greenland specimens.

These same differences are apparent between the medium-sized Point Barrow specimens and those from Greenland; in addition, the former have somewhat shorter spires and more rapidly increasing body whorls.

The same differences are also found in the largest specimens mentioned above, but in these the canal is even longer, although it is prob-

ably in proportion to the size of the shell. These largest specimens seem to merge into *B. pacificus*.

Dr. Thorson has suggested that these medium-sized and large specimens may be a new variety of *B. truncatus*, but it seems inadvisable to describe a new variety until a thorough study and revision of the northern species of *Boreotrophon* have been made.

DISTRIBUTION: *B. truncatus* is known from the Gulf of Maine; from Greenland; Iceland, the British Isles, the Faroes, northern and southern Norway, Spitzbergen, the Barents Sea, and the Siberian Arctic. It is new to Point Barrow and the Alaskan Arctic.

Family BUCCINIDAE

Genus *Buccinum* Linnaeus, 1758

Masses of egg capsules of *Buccinum* were found from the time the ice went out until the middle of October. Such masses were sometimes dredged but more often were washed ashore during storms. They ranged from masses of less than a hundred capsules to other masses over 6 inches long and from 2 to 3 inches in breadth. The capsules varied in size; some were smooth, others were wrinkled. Toward the end of September one mass of capsules still contained eggs. At the beginning of October one mass belonging to another species was made up of both empty capsules and ones containing eggs. In the middle of October, a mass from still another species contained capsules in which there were from 3 to 5 embryos from 1.8 to 4 mm. in length that were still feeding on "nurse eggs." And on October 16, masses belonging to a fourth species contained capsules with eggs only, while in other masses the capsules held from 10 to 12 embryos without shells; still others contained 4 or 5 larger embryos with "nurse eggs"; one capsule contained 14 embryos in an earlier stage, while still other capsules had from 15 to 17 embryos with eye spots.

Buccinum glaciale Linnaeus, 1761

And var. *morchianum* Dunker

PLATE 9, FIGURES 1-7, 10, 13

Buccinum glaciale Linnaeus, 1761, p. 523.—Tryon and Pilsbry, 1878-1898, vol. 3, pl. 76, fig. 345.—Abbott, 1954, p. 226, pl. 24t.

Tritonium carinatum Dunker, 1858, pt. 1, pl. 2, figs. 3, 4.

Buccinum morchianum Dunker, 1858, pt. 1, pl. 2, figs. 2, 3.—Tryon and Pilsbry, 1878-1898, vol. 3, p. 185, pl. 78, fig. 371.

Buccinum carinatum Tryon and Pilsbry, 1878-1898, vol. 3, p. 185, pl. 78, fig. 372.

Buccinum glaciale var. *parallelum* Dall, 1918, p. 231.

Buccinum glaciale parallelum Dall, 1921, p. 98, pl. 8, fig. 10.—Oldroyd, 1927, pt. 1, p. 239, pl. 17, figs. 9, 10; pl. 27, figs. 1, 2.

Over 50 living specimens of this species were collected from 19 stations. One specimen only came from Eluitkak Pass (40 feet, stony

bottom) and one was taken on Apr. 12, 1950, at a depth of 80 feet by means of a trap through a hole in the ice. The remaining specimens were from depths of 120 to 522 feet, the greatest numbers coming from 125 feet (14), 175 feet (7), 150 feet (4), 420 feet (4), 216 feet (3), and 453 feet (3). Dead shells were usually inhabited by hermit crabs. The largest specimen is about 70 mm. in height; the smallest, 15.5 mm.

OTHER MATERIAL EXAMINED: Numerous specimens from localities from Point Barrow to Plover Bay and to the Aleutians; 1 specimen from Labrador; over 10 from Spitzbergen.

DISCUSSION: *B. glaciale* is characterized by moderately convex whorls and strong longitudinally oblique folds that are strongest at the sutures and, in the body whorl, terminate at a strong carina that produces an angle about midway of the whorl. It is spirally sculptured by fine threads grouped in bands of from about 4 to 10, sometimes 15 or even more, separated by interspaces varying from one-fourth to one-half the width of the bands. The fine incremental lines that cross these spiral threads give them a wavy appearance, and the interspaces and secondary grooves are likewise crossed by these fine vertical lines.

In some specimens examined the whorls are almost flat (pl. 9, fig. 5), in others they are much more convex than in typical specimens. The shells vary from relatively slender to almost squat, and although the ones with the more convex whorls are usually the more inflated, there are a few wide, squat shells with almost straight whorls. The number and strength of the longitudinal folds vary markedly; in some specimens the folds fade out before reaching the carina (pl. 9, fig. 2) and in others they remain strong and terminate in a nodule at the keel (pl. 9, fig. 4); in some shells these axial folds are regular and in others they are wavy and occasionally they are interrupted somewhat as in *B. tenue*. In some shells the carina or keel is weak (pl. 9, fig. 2), and in a few there is no definite carina (pl. 9, fig. 6); in others there may be two carinae (pl. 9, fig. 1); in still others there may be a cord both above and below the keel; and in still others there may be 3 cords with no angle formed. In a few shells an angle is formed at the termination of the axial folds without a definite carina being present. Sometimes, instead of being drawn into bands, the spiral lirae are more evenly spaced, giving the wavy effect characteristic of *B. angulosum*. In some specimens of *B. glaciale* the mouth is more rounded than oval and the aperture is much less than one half the length of the shell; in others the aperture is nearly as long as the remainder of the shell.

In all except one of the 29 specimens examined from Plover Bay, the shells average much heavier than those from other localities and they also increase in size more rapidly. With one exception, a carina is present but the angulation is slight; one specimen has 2 carinae but is not angular. The spiral striae also tend to be gathered into

wider bands than usual; in a few the bands of striae are coarser and have deeper and wider interspaces.

On the whole, the Point Barrow specimens are fairly typical, but a few run the gamut of variations. In only a few are the carina and angle insignificant, but in one from 125 feet (39.2 mm. high) there is no carina and the whorl is not angled at the termination of the axial folds. An adult shell from 150 feet (65 mm. high) has a small carina and almost no angle; one from 184 feet (42.5 mm. high) has 2 carinae with a suggestion of a third between these two in the last half of the last whorl. The more posterior of these 2 carinae is not half the size of the anterior one but practically all of the axial folds terminate there instead of at the stronger one, which is in the customary position about the middle of the whorl.

A shell measuring 48 mm. high by 24.6 mm. in diameter, with an aperture 20 mm. long and a spire 28 mm. long, that was dredged from 125 feet (pl. 9, fig. 6) has certain characteristics of *B. donovani* Gray: the spire is long and slender and the aperture is relatively short; there is no keel at the shoulder, merely a suggestion of a carina. The axial folds are strong and terminate at the shoulder. The shell is heavier and the whorls less convex than in *B. donovani* that I have examined, and it lacks the patulous aperture and sinuated outer lip of *B. donovani*. It is undoubtedly a variant of *B. glaciale* rather than of *B. donovani*.

DISTRIBUTION: Point Barrow to Juan de Fuca Strait; Johnson (1934) gives the Atlantic range as Greenland to the Gulf of St. Lawrence; Thorson (1944) also lists it from Jan Mayen, Spitzbergen, the Kara and Barents Seas, Franz Joseph Land, Novaya Zemlya, and the Siberian Arctic; also Kamchatka and Japan.

Variety *morchianum* Dunker, 1858

PLATE 9, FIGURES 7, 10, 13

A total of 10 shells, at least half of which were living, were collected: 1 small dead shell washed ashore; 1 dead shell (67.4 mm., the largest) and 2 living (19.5 mm. and 21 mm.) came from 130 feet; 2 living (17 mm. and 47.5 mm.) from 175 feet; 1 living (33 mm.) from 213 feet; 1 living (65 mm.) from 477 feet; 1 recently dead (65.5 mm.) from 453 feet; and 1 living (25.7 mm.) from 522 feet.

OTHER MATERIAL EXAMINED: About 40 specimens from the Pribilofs, the Aleutians, and Cook's Inlet, and 1 from Cape Prince of Wales.

DISCUSSION: This is the shell that was described by Dall in 1919 as *B. glaciale* var. *parallellum*. It differs from typical *B. glaciale* in that the spiral striae are usually somewhat coarser and tend toward fewer per band, with less pronounced and narrower interspaces between

the bands. The secondary grooves between the striae of the bands are usually more prominent in var. *morchianum*. The basal whorl has 2 carinae, one of which is in the same position as that in *B. glaciale*; sometimes it is angled at this carina and sometimes not. The other carina, more apical in position, is usually stronger and extends around the body whorl and one or two more whorls, often forming a sloping shoulder. Where the carina crosses the axial folds, the latter are drawn out into nodules and the folds usually change direction at this point. Young specimens are covered by a thin, closely adherent, slightly fringed periostracum that is usually worn off in larger specimens. Some young specimens are difficult to distinguish from *B. ciliatum*, both the periostracum and the sculpture being similar. They differ from *B. ciliatum* in the presence of the carina and in a slightly more recurved canal and slightly deeper groove behind the canal.

There is great variation in the weight of shells of equal size; some shells are robust, others gradually tapered; some are strongly carinated and angular, others scarcely carinated and are rounded, still others have 3 carinae, and still others have one carina with one or more strong cords; some have fewer, others more ribs than typical specimens; and in some the bands of spiral striae are prominent and sometimes separated by wide interspaces.

DISTRIBUTION: Point Barrow, Cape Prince of Wales, the Pribilofs, the Aleutians, eastward to Cook's Inlet; the Kurile Islands. The Point Barrow specimens extend the range into the Arctic to the 71st parallel.

Buccinum plectrum Stimpson, 1865

PLATE 9, FIGURES 11, 12

Buccinum plectrum Stimpson, 1865, p. 374.—Martini and Chemnitz, 1883, ed. 2, pl. 91, fig. 2.—Oldroyd, 1927, pt. 1, p. 239, pl. 5, fig. 5.—Morris, 1952, p. 122, pl. 28, fig. 25.

Approximately 40 live specimens and about 15 shells (in various stages of decomposition), that were either empty or occupied by hermit crabs, were collected. One live specimen was taken on May 17, 1950, at a depth of 37 feet by means of a trap lowered through a hole in the ice. All the other living specimens came from 16 stations from depths ranging from 120 to 522 feet, the highest number, 13, coming from the latter depth. In only three instances was there more than 1 specimen from any station of less than 341 feet: 3 from 295 feet, 3 from 120 feet (Sept. 15, 1948), and 2 from 125 feet. The largest shell was nearly 70 mm., the largest living one about 60 mm., and the smallest living one about 20 mm. in height. Foraminifers, bryozoan colonies, and barnacles up to 8 mm. in diameter were present

on living shells. In some specimens the outer portion of the ribs is worn flat.

OTHER MATERIAL EXAMINED: Numerous specimens from localities ranging from Point Barrow to Nunivak Island, the Pribilofs, the Aleutians, the Inland Passage, and Puget Sound.

DISCUSSION: This is one of the commonest species of *Buccinum* in the area investigated off Point Barrow base. In general appearance it is most closely allied to *B. tenue*, but the shell is heavier, the throat is whiter, and the longitudinal folds or plications are stronger and appear to be less numerous than in *B. tenue*. However, because of the broken or interrupted character of the plications in *B. tenue*, this difference in number is more apparent than real. In *B. tenue* the spiral sculpturing is fine and nearly uniform, whereas in *B. plectrum* the spiral threads are coarser and are grouped into fascicles of four or more separated by a narrow interspace.

Shells of *B. plectrum* from Point Barrow are heavier than those from other localities (with the exception of a large specimen from Chichagoff Island). This characteristic applies to both the shells of the present collection and those in the U. S. National Museum that were collected years ago. Not only is the shell heavier but the groups of spiral threads are also heavier and raised higher. The height of the raised sculpture, or groups of spiral threads, seems to be in direct proportion to the weight of the shell.

In addition to having a heavy shell, the specimen from Chichagoff Island has constricted sutures, prominent ribs (that do not extend to the canal), a flared mouth, and dark color. It might be said to bear the same relationship to *B. plectrum* that var. *rhodium* does to *B. tenue*.

In some shells of *B. plectrum* the longitudinal folds are interrupted or broken, much as in *B. tenue*, but examination reveals that more often than not this interruption has been caused by injury. In some shells, instead of the spiral threads being crowded into fascicles and separated by distinct grooves or interspaces, the spiral threads are more nearly uniformly spaced and the interspaces are shallow, giving the effect of a missing thread rather than a definite groove. In one specimen examined from Afognak Bay the lip had been broken and in the repaired portion of the shell the sculpture was much finer than in the preceding part of the whorl and the spiral threads were not grouped into fascicles or bands. Had two entire shells had such different sculpturing, it is probable that they would be assigned to different species. There is also variation in the convexity of the whorls and in the degree of constriction of the sutures.

DISTRIBUTION: The Pacific range of *B. plectrum* is from Point Barrow to Puget Sound; Johnson (1934) gives the Atlantic range as

Greenland to the Gulf of St. Lawrence, but Thorson (1944) does not list it from Greenland.

Buccinum tenue Gray, 1839

PLATE 9, FIGURES 8, 9

Buccinum tenue J. Gray, 1839, p. 128, pl. 36, fig. 19.—Morris, 1947, p. 150, pl. 36, fig. 3; 1951, p. 196, pl. 36, fig. 3.—Abbott, 1954, p. 225, pl. 24u.

Seven living specimens were taken from 7 stations from depths ranging from 110 to 341 feet, only 2 of these coming from over 130 feet. One live specimen was washed ashore in September 1949, and 2 others were taken in April and May 1950 by means of baited screen traps lowered through holes in the ice to depths of 80 and 64 feet, respectively.

OTHER MATERIAL EXAMINED: Numerous specimens from localities from Bernard Harbor, Icy Cape, and south to eastern Siberia, Kamchatka, the Pribilofs, the Aleutians, and British Columbia; also from the Grand Banks, Newfoundland, Greenland, and Spitzbergen.

DISCUSSION: Typical *B. tenue* is sculptured by fine, more or less evenly spaced spiral threads that are crossed by fine incremental lines that lend a wavy appearance to the spiral threads and produce an over-all pattern. The sutures are moderately constricted and the whorls moderately convex. Broken or interrupted folds or plications cross the whorls, and in the last whorl they tend to become weaker beyond the periphery. The periostracum is absent as often as it is present; it may be entirely absent in some younger specimens, and may be nearly all retained in some large shells, but more often it is present in patches only (pl. 9, fig. 9).

Instead of becoming weak or obsolete beyond the periphery of the last whorl, in some specimens the longitudinal plications continue strongly to the canal. In some the plications on the spire and body whorl are sparse and weak; in others they are numerous and strong. In some the whorls are much more convex and the sutures much more constricted than in others; this convexity is not associated with number or strength of the axial plications. On the whole, the very large specimens tend toward very convex whorls and constricted sutures. The spiral threads vary in fineness and, although they are never actually grouped into fascicles, one may be unusually close to another, giving the appearance of a missing thread. Some shells may be approximately twice as thick or heavy as others of the same size. The spire may be much longer in proportion to the aperture in some than in others. There seems to be no consistency in these variations as related to locality. One shell from Point Barrow has more inflated whorls and deeper sutures than the others, while another

is slenderer and smother. However, many shells (of *B. tenue* and other species) from Plover Bay tend to be large and heavy.

The 6 specimens of Dall's variety or subspecies *rhodium* are all from Plover Bay, eastern Siberia. Although these shells are sturdier and much larger than the average *B. tenue*, more specimens may show that they are just a Plover Bay *B. tenue*. Other than that of size, the differences between var. *rhodium* and *B. tenue* (heaviness, prominence of the plications and their continuance to the canal) exist in varying degrees in specimens of *B. tenue*.

DISTRIBUTION: From Bernard Harbor (Northwest Territories), Point Barrow, south to the Aleutians and east to Puget Sound; eastern Siberia, and Kamchatka; the Grand Banks and Newfoundland; western Greenland; Spitzbergen. It is new to Point Barrow.

***Buccinum polare* Gray, 1839**

PLATE 10, FIGURES 1-4

Buccinum polaris J. Gray, 1839, p. 128.

Buccinum polare Martini and Chemnitz, 1883, ed. 2, pl. 9, fig. 4.

Buccinum orotundum Dall, 1907, p. 152.

Buccinum pemphigus orotundum Dall, 1921, p. 99, pl. 12, fig. 9—Oldroyd, 1927, pt. 1, p. 245, pl. 14, fig. 8.

About 9 specimens were collected: During March, April, and May 1950, 5 were taken at depths of 64 and 80 feet by means of baited screen traps lowered to the bottom through holes in the ice; 1 (54 mm. high) was dredged at 80 feet (August 21, 1948); 2 (21 mm. and 26 mm.) at 341 feet; and 1 (30 mm.) at 438 feet. The largest specimen (57 mm. high) came from 80 feet on Mar. 20, 1950.

OTHER MATERIAL EXAMINED: 1 specimen from Bernard Harbor (Northwest Territories), over 100 specimens from localities from Point Barrow south to Nunivak Island, the Pribilofs, and the Aleutians; 20 from Plover Bay and Kamchatka; 1 from Newfoundland; 3 from Spitzbergen.

DISCUSSION: A thin, gray periostracum is present in the living specimens but often begins to flake off when the shell dries. Although the shell is typically thin, there are specimens in which it is fully twice as thick and heavy as in others; it varies from slightly ventricose to decidedly ventricose, and this same variation is evidenced in the whorls. The last whorl is marked by from one to three spiral carinae that usually create a keel, but not necessarily; the carina or carinae may extend apically for from 3 to 5 whorls. In some shells the carinae are scarcely perceptible and there is no keel or angulation. The whorls are covered with spiral threads, which are crossed by the incremental lines, giving a shallowly reticulate appearance. In some shells these spiral threads are much coarser and the resulting sculpture is similar to that of *B. ciliatum* (cf. USNM 213132, 33922, and one

of 33911). There is also variation in the number and strength of the axial plications, some shells having twice as many as others. All possible combinations of these variations are represented in the shells examined.

Examination of the specimens of *B. pemphigus orotundum* in the U. S. National Museum revealed that they are not a variety or subspecies of *B. pemphigus* (Dall, 1921, p. 99) but of *B. polare*. Recourse to the original description of *B. orotundum* Dall (1907, p. 152) further revealed that Dall himself stated that *B. orotundum* is an extremely ventricose form of *B. polare*. Placing var. *orotundum* under *B. pemphigus* apparently was the result of confusing the specific names of *B. polare* and *B. pemphigus*. The type of *B. orotundum* is an exceptionally large and ventricose *B. polare* and there are all gradations between it and typical *B. polare*. The var. *orotundum* has the comparatively small nucleus of *B. polare*, bearing little resemblance to the very broad, blunt nucleus of *B. pemphigus*.

DISTRIBUTION: From Bernard Harbor and Point Barrow south to the Aleutians; also eastern Siberia and Kamchatka.

Buccinum angulosum Gray, 1839

And varieties *normale*, *subcostatum*, and *transliratum* Dall

PLATE 10, FIGURE 10; PLATE 11

Buccinum angulosum Gray, 1839, p. 127, pl. 36, fig. 6.—Oldroyd, 1927, pt. 1, p. 255, pl. 5, figs. 1-3; pl. 17, figs. 9, 10.—Morris, 1952, p. 122, pl. 28, fig. 22 [= var. *subcostatum*].

Buccinum angulosum normale Dall, 1885b, p. 179, pl. 3, fig. 1.—Oldroyd, pt. 1, p. 255, pl. 5, fig. 6.

Buccinum angulosum subcostatum Dall, 1885b, p. 179, pl. 3, fig. 2.

Buccinum angulosum var. *cnismatopleura* Dall, 1919b, p. 328.

Buccinum angulosum var. *transliratum* Dall, 1919b, p. 328.

Buccinum cnismatopleura Dall, 1925, p. 7, pl. 4, fig. 4.

Buccinum angulosum cnismatopleura Oldroyd, 1927, pt. 1, p. 255, pl. 12, fig. 4.

Five specimens of true *B. angulosum* were collected: 2 (48 mm. and 36 mm. high) were washed ashore; 1 (55.5 mm.) was dredged at Eluitkak Pass; 1 (59 mm.) at 522 feet; and 1 was taken on May 17, 1950, at a depth of 64 feet by means of a trap lowered through a hole in the ice.

Twenty-six specimens of var. *subcostatum* were collected: 13 (18.5 to 50 mm.) were taken in screen traps between March 10 and June 13, 1950, at depths of 37 and 64 feet; 9 (12 to 51 mm.) were dredged at Eluitkak Pass (on three different days); and 2 (14 mm. each) were dredged at 110 feet on Sept. 8, 1948.

Sixteen specimens of var. *transliratum* were collected: 13 (36 to 51 mm.) were taken in screen traps between Mar. 20 and June 6, 1950, at depths of 37 to 80 feet; and 1 (51.5 mm.) was dredged at 213 feet.

Eighteen specimens of var. *normale* were collected: 6 (37 to 41.5 mm.) washed ashore in September 1949; and 12 (30.5 to 43.5 mm.) were taken in screen traps between Mar. 10 and June 13, 1950, at a depth of 37 feet.

With the exception of one from 522 feet and one from 213 feet, all 69 of these specimens came from depths of 110 feet or less, and 39 were taken in winter by means of screen traps. The shells were frequently partially covered with hydroids.

OTHER MATERIAL EXAMINED: About 17 specimens of *B. angulosum* from Bernard Harbor, Point Barrow, Icy Cape, and Kotzebue Sound; 2 from Spitzbergen.

Four specimens of var. *subcostatum*, including the figured type, from Point Barrow, Station 24, Canadian Arctic Expedition, and Icy Cape.

About 15 specimens, including the type, of var. *transliratum* from localities from Point Barrow to Unimak Island in the Aleutians.

Over 100 specimens, including the type lot, of var. *normale* from localities from Bernard Harbor to Point Barrow, to Kotzebue Sound; 1 from eastern Greenland; 1 from Spitzbergen.

DISCUSSION: In both true *B. angulosum* and var. *normale* there are fine to medium-fine spiral threads that are crossed by about equally strong incremental lines that give the surface a wavy or shallowly reticulate appearance. In the forms of var. *subcostatum* and var. *transliratum* there is more of a tendency toward fasciculation of the fine spiral threads and the incremental lines are not so prominent as in the above two forms, but they are quite evident and exert enough influence to produce a wavy effect and make lines across the shallow interspaces.

But if one examines a sufficient number of shells, it is possible to find almost every intergradation between the two types of sculpture. In some shells of the *transliratum* variety the spiral lines are nearly evenly spaced and there is little evidence of an interspace. It is also possible to find shells with both types of sculpture on the same shell. And in some shells of the *B. angulosum* type the sculpturing approaches that of *B. ciliatum*, with a heavier spiral cord alternating with a weaker one and with the incremental lines no stronger than the weaker spiral cord, or perhaps not so strong.

One specimen that was assigned to var. *transliratum* has a much heavier than typical shell with a flaring lip—both characteristics suggesting *B. angulosum*; it has two spiral carinae that suggest var. *transliratum* (the anterior carina is weaker than the posterior one and the shell is slightly nodulous at the junction of the posterior carina and the ribs); the sculpture is that of var. *transliratum*. Four shells that were assigned to var. *subcostatum* have discrepancies that make

them doubtful, and there are two that are even more questionable. There is one very questionable var. *normale*, and several others that could as easily be assigned to one form as the other.

Plate 11 depicts *B. angulosum* and its varieties. Figure 7 of plate 11 is of a small *B. angulosum* with the typical few but prominent longitudinal ribs, a strong carina, and an angle about midway of the last whorl. In figure 6 the ribs are strong, the carina is only a suggestion, and the angle is slight. In figure 5 there is no carina, no angle, and the ribs are much less prominent. In figure 4, which is midway in shape between figures 5 and 6, there is no carina, and the ribs are similar to those in figure 5. Specimens shown in figures 4 and 5 would be classed as var. *subcostatum*, but figure 6 is midway between the typical *B. angulosum* and var. *subcostatum*.

Although it has only three strong cords and a very weak fourth (the type has four and a weak fifth), the specimen in figure 11 could be placed in var. *transliratum* without question. The specimen in figure 12 has two strong cords and a weaker third, and the ribs are stronger than in figure 11. The specimen shown in figure 13 has strong ribs and only one spiral cord and is intermediate between *B. angulosum* and var. *transliratum*.

The specimens in figures 1 and 2 could be placed in var. *normale* without hesitation. Figure 3 is of a var. *normale* with flatter whorls and a less flaring mouth; the apparent longitudinal ribbing is abnormal—the result of injuries.

The specimen in figure 8 is midway between var. *normale* and var. *subcostatum*, having a somewhat flared mouth like var. *normale* and weak ribs as in var. *subcostatum*. Its one cord, even though weak, allies it with *B. angulosum*. The specimen in figure 9 has two fairly strong cords, almost no ribbing on the last whorl, and no angle, while the one in figure 10 has the heavier shell of *B. angulosum*, the flaring outer lip of var. *normale*, ribs more like those of var. *subcostatum*, and two cords that suggest relationship with var. *transliratum*.

After examining hundreds of specimens of this species and its varieties, I believe that the subspecies *subcostatum*, *transliratum*, and *normale* are only forms of *B. angulosum*. Certainly there is no more variation in all these forms than there is in those of *Thais lamellosa*, in which it has generally been conceded that the subspecies should be dropped.

The only two existing specimens of *B. angulosum cnismatopleurum* Dall are pathological ones. The type specimen had been injured several times, had made repairs, and continued growing. The resulting shell is a squat form that is heavier and has more prominent ribs than typical forms of var. *transliratum*. The second specimen, from between Cape Beaufort and Cape Lisburne, is also a var.

transliratum that suffered no less than three major injuries. The shell, which seems slightly heavier than the average var. *transliratum*, is a much-worn specimen in which the cords are lacking. *B. cnis-matopleurum* is not a valid varietal name, much less a subspecific one.

DISTRIBUTION: *B. angulosum*: Bernard Harbor and Point Barrow to Kotzebue Sound; also Spitzbergen. Var. *subcostatum*: Point Barrow to Icy Cape. Var. *transliratum*: Point Barrow south to Bristol Bay and Unimak Island in the Aleutians. Var. *normale*: Bernard Harbor and Point Barrow south to Kotzebue Sound; also eastern Greenland and Spitzbergen.

Buccinum fringillum Dall, 1877

PLATE 10, FIGURES 6, 7

Buccinum fringillum Dall, 1877, p. 4.^a—Martini and Chemnitz, 1883, ed. 2, vol. 3, abt. 1c, p. 88, pl. 91, fig. 9.—Oldroyd, 1927, pt. 1, p. 256.

Two live specimens were taken on Oct. 11, 1949, at a depth of 453 feet. Including the 2 whorls of the nucleus, the larger of the 2 specimens has 7 whorls, the smaller 6.5. Both are covered with periostracum (heavier and coarser in the larger specimen) that projects from the surface in heavily fringed axial folds. The larger shell is 37.7 mm. high by 24.6 mm. in diameter; the smaller, 28 by 20.5 mm. Small barnacles, small colonies of bryozoans, and foraminifers were growing on the periostracum.

OTHER MATERIAL EXAMINED: The type and 7 other specimens from the north end of Nunivak Island.

DISCUSSION: *B. fringillum* is more closely allied to *B. ciliatum* than any of the other species of *Buccinum* from Point Barrow, but the shell is thinner and much more inflated, the periostracum is markedly more fringed, and the sculpture is finer than that of *B. ciliatum*. (The type locality is the north end of Nunivak Island in Bering Sea, not "Arctic Ocean near Icy Cape," as given by Oldroyd.)

DISTRIBUTION: Point Barrow, and the north end of Nunivak Island at 54 feet. The Point Barrow specimens represent an extension of distribution in depth and a northerly extension in range from about the 60th to the 71st parallel of latitude.

^a Dall (1921, p. 101) gives the following reference for *Buccinum fringillum* Dall, 1877: Proc. Calif. Acad. Sci., vol. 7, p. 9. Vol. 7, pt. 1, ser. 1, of the official proceedings of the Academy, covering the meetings of 1876, was published in 1877. *Buccinum fringillum* is not mentioned in pt. 1 of vol. 7 and there is no pt. 2, for the Academy did not begin publishing the second series of the Proceedings until 1888. Thus a period of 11 years elapsed during which no official proceedings were published. It is probable that Dall expected his paper to be published by the Academy, for the separate that was published followed the format of the Proceedings. The page number is more difficult to explain, for the separate (see "References") containing the description is pagged from 1 to 6, and *B. fringillum* is described on p. 4.

Buccinum ciliatum Fabricius, 1780

PLATE 10, FIGURES 8, 9

Tritonium ciliatum Fabricius (not Gould), 1780, p. 401.

Buccinum ciliatum Tryon and Pilsbry, 1879-1898.—Martini and Chemnitz, 1883, ed. 2, vol. 3, abt. 1c, p. 29, pl. 78, figs. 5, 6.

Six living specimens were taken from 8 stations ranging in depth from 162 to 741 feet. The shells range from 15.5 mm. in height by 9 mm. in diameter (341 feet) to 33.5 by 19 mm. (420 feet). Three empty shells were also found.

OTHER MATERIAL EXAMINED: 17 specimens from localities ranging from Point Barrow (1 dead specimen) to Plover Bay, the north end of Nunivak Island, and the Pribilofs; 1 specimen from the northeast part of the Grand Banks, 1 from the southeast coast of Newfoundland, 1 from Murray Bay, Quebec; 12 from Greenland; 1 from Spitzbergen.

DISCUSSION: In slender specimens the aperture is shorter than the remainder of the shell but in more squat specimens the aperture is the longer. The specimens from Point Barrow range from slender to squat. They are covered with a tan, hirsute periostracum that is often worn off on the outer margins of the ribs. The specimen from 420 feet is tumid, with at least 17 ribs; a smaller one (29.5 by 16.5 mm.) from 341 feet has about 19 ribs on the last whorl. Specimens examined from Plover Bay tend to be somewhat squat, with the aperture longer than the remainder of the shell.

The spiral sculpture varies from wide, flattish bands to prominent ridges, with a thread in each interspace. Specimens examined from Greenland were characterized by flatter, less pronounced spiral sculpturing than the Point Barrow ones. About half of the Greenland shells were nearly twice as heavy as the others of comparable size.

DISTRIBUTION: The localities mentioned above and, in addition, the following: North of the mouth of the Mackenzie River, Baffin Land, Labrador; Jan Mayan, Beeren Island, Novaya Zemlya; the White Sea, the Murman Coast, the Siberian Arctic (Thorson, 1944). Dall (1921) gives the Pacific range as "Point Barrow, Arctic Ocean, south to the Aleutian Islands and eastward to the Shumagins." The specimen from the Shumagins is a small, dead, eroded shell that does not look like *B. ciliatum*. The most southerly specimen that I examined came from off the Pribilofs. The present specimens are the first living ones from Point Barrow and the second record from north of Bering Strait.

Buccinum undatum (Linnaeus, 1761)Var. *striatum* Pennant

PLATE 10, FIGURE 5

Buccinum undatum Linnaeus, 1758, p. 740; 1767, p. 1204.

Buccinum undatum Linnaeus var. *striatum* Pennant, 1812, vol. 4, p. 272.

A single living specimen, measuring 24.8 by 14.6 mm., was dredged at a depth of 477 feet on Sept. 6, 1949.

DISCUSSION: This specimen does not conform with any species that I have seen. Dr. W. J. Clench (personal communication) considers it very close to the var. *striatum* of *B. undatum*. It is a young shell with a thin gray periostracum with delicate axial folds beset with hairs much as in *B. ciliatum*. The spiral sculpture is also suggestive of *B. ciliatum* in that heavier axial threads alternate with smaller ones, and there is also a little of the wavy effect characteristic of *B. angulosum*. However, the general structure of the shell rules out *B. ciliatum*, for it is larger in diameter in proportion to the length; the aperture is longer in proportion to the remainder of the shell, the canal is not reflexed, the whorls are more tumid and enlarge more rapidly, and the entire shell is much thinner and lacks the sturdiness of *B. ciliatum*. On the last whorl there are about 22 axial ribs that evanesce at the periphery, and the next to the last whorl has about the same number, that become increasingly faint toward the apex.

DISTRIBUTION: *B. undatum* has been recorded from Labrador to New Jersey and from Europe; the var. *striatum* has been recorded from off Labrador from 60 to 80 fathoms.

Genus *Pyrulofusus* Mörch, 1869*Pyrulofusus deformis* (Reeve, 1847)

PLATE 13, FIGURES 3-5

Fusus deformis Reeve, 1847, vol. 4, *Fusus*, pl. 12, figs. 45a-b.

Pyrulofusus deformis Dall, 1921, p. 89.—Oldroyd, 1927, pt. 1, p. 184.

Two living and 2 dead specimens of this species, the largest snail taken at Point Barrow, were collected: The smallest, consisting of about 2.5 nuclear and one postnuclear whorl, and which measures 35.9 mm. high by 19.6 mm. in diameter, was taken at a depth of 438 feet; the largest (142 by 83 mm.) was dredged at 130 feet (Sept. 15, 1948); the 2 dead specimens (72.4 by 28.2 mm. and 83.5 by 42 mm.) were taken from 453 feet and 120 feet (Sept. 15, 1948), respectively. Approximately one fourth of the surface of the largest shell (pl. 13, fig. 5), a live specimen, was covered with colonies of encrusting bryozoans of at least three different species, and several small barnacles were also attached to it. Even the smallest shell (pl. 13, fig. 3), also

a live specimen, had one barnacle and a few cells of bryozoan colonies growing on it.

OTHER MATERIAL EXAMINED: About 25 specimens from localities ranging from Icy Cape (one dead shell from the beach) to the Pribilofs, the Aleutians, and southeast of the Aleutians.

DISCUSSION: This species exhibits variations in the prominence of the obliquely longitudinal ribs and in the character of the sculpturing. Small specimens show spiral threads that are given a wavy effect by the incremental lines. The spiral threads vary in coarseness, and in some shells they may be grouped; in the larger specimens the shells are often too worn to show the sculpturing, but in some there are several irregularly spaced spiral cords on the last whorl.

DISTRIBUTION: Point Barrow to around Unimak Island in the Aleutians; also Spitzbergen. The only reference to a living shell north of the Arctic Circle appears to be that of the type from Spitzbergen. The Point Barrow specimens represent a new locality record and the first living specimens from Arctic Alaska.

Genus *Beringius* Dall, 1894

***Beringius stimpsoni* (Gould, 1860)**

And var. *malleatus* Dall

PLATE 13, FIGURES 1, 2

Buccinum stimpsoni Gould, 1860, p. 325.

Strombella malleata Dall, 1885a, p. 525.

Beringius malleatus Dall, 1925, p. 5, pl. 6, fig. 5.—Oldroyd, 1927, pt. 1, p. 195, pl. 22, fig. 5.

Beringius stimpsoni Dall, 1925, p. 6, pl. 7, fig. 2.—Oldroyd, 1927, pt. 1, p. 195, pl. 21, fig. 2.

One dead and 5 living specimens were collected: the largest, the dead shell (107 mm. in height by 53.8 mm. in diameter, and fore-shortened by breakage at both ends), was taken at 125 feet; 1 (12.7 mm. in height) at 162 feet; 2 (44.7 mm. and 48.4 mm.) at 453 feet; and 2 (60.4 mm. and 64.6 mm.) at 522 feet. One of the shells had been broken and repaired several times. Although even the living shells are worn and encrusted, fine spiral lines are visible.

OTHER MATERIAL EXAMINED: Nine specimens labeled *B. malleatus* and a few *B. stimpsoni* from localities ranging from Point Barrow (1 beach specimen) to the Pribilofs.

DISCUSSION: When Gould wrote the original description of *B. stimpsoni*, he did not figure the species. Later Dall (1925) selected a specimen to represent the type, and his figure of it (pl. 7, fig. 2) is the same figure as appears in Oldroyd (1927, pt. 1, pl. 21, fig. 2). Unfortunately, in the text of his paper Dall confused² the museum

numbers of the shells, stating that USNM 40979 is the type of *B. malleatus* and this number was cataloged as the type. Actually, the shell that he figured is USNM 15170. The shell labeled the type is a 7-sided form similar to the figure of *B. stimpsoni* in Oldroyd (1927, pt. 1, pl. 21, fig. 2).

I believe that *B. malleatus* is only a variety of *B. stimpsoni*. In his original description of *B. stimpsoni*, Gould wrote: "shell large, solid, elongate, . . . whorls 6 to 8+, pyramidal, pentagonal, the last anteriorly excavated, at which place the spiral ribs terminate in a wave (carina)." Examination of many specimens reveals that the shells may be from 5-sided to 7-sided.

In his original description of *B. malleatus*, Dall compares it with *Beringius beringi* (Middendorff), stating that the shell is "long and slender," has "few large (generally only five) transverse ribs, between which the space is nearly flat rather than concave, and a sharp carina on the anterior periphery of the last whorl, on which the suture is laid."

Examination of specimens of both *B. stimpsoni* and var. *malleatus* shows that the fewer the ribs the flatter the surface between them, but there is always a certain amount of excavation even in shells with the fewest number of sides (see pl. 13, fig. 1). This excavation is evident also in the figure by Oldroyd (1927, pl. 22, fig. 5). Dall speaks of a dark purple color in connection with *B. malleatus*, but examination shows that some specimens are brown and others are nearly ash colored. Gould speaks of an ash-colored or pale rust shell, with pale ash-colored or leaden-colored throat in *B. stimpsoni*.

The dead specimen mentioned above from 125 feet is very similar to that figured by Dall for the type specimen of *B. malleatus* except that in the latter there is no carina on the last whorl, the ribs simply terminating at the periphery. In the shell from the MacGinitie collection there is a definite carina at the termination of the ribs and the shell is somewhat excavated both anteriorly and posteriorly (between the ribs) to it (see pl. 13, fig. 1). In both shells the last whorl is 5-sided. In the MacGinitie shell the penultimate whorl is only 4-sided, lending a definite squarish appearance to the shell, but even on this whorl the space between the ribs is not exactly flat. One of the postnuclear whorls is 6-sided. The shell is heavy and brown, with at least 7 whorls. It can be referred to *B. stimpsoni* var. *malleatus*.

The 60.4 mm. specimen from 522 feet has 6 sides on the last whorl and 7 on the penultimate whorl, and the space between the ribs, or "waves," is concave (pl. 13, fig. 2). There are 5.5 whorls, including the nucleus. The shell is ash colored, but reddish brown where worn, and the throat is a leaden brown. The spiral sculpturing is the same

as that of the shell above and, except for the carina at the periphery of the last whorl, the same as that of Dall's type of *B. malleatus*. This shell can be referred to *B. stimpsoni* var. *stimpsoni*.

The specimens in the U. S. National Museum vary in the number of sides, in the presence or absence of a carina at the periphery, in color, and in the degree of concavity between the ribs. Depending on the age of the shell, there are from 2 to 4, more or less flattened, spiral cords posterior to the carina or periphery of the last whorl. In some shells (especially in young specimens) the aperture is longer than the remainder of the shell.

DISTRIBUTION: From Point Barrow to the Pribilofs. Living specimens have not been reported previously from Point Barrow.

Beringius beringi (Middendorff, 1849)

And var. *kobelti* Dall

PLATE 12, FIGURES 1-6

Tritonium (Fusus) behringii Middendorff, 1849a, p. 243; 1849c, pt. 2, p. 147 pl. 3, figs. 5, 6; 1849d, pt. 2, p. 476, pl. 3, figs. 5, 6.
Volutopsius (beringii Midd. var.?) *kobelti* Dall, 1902, p. 528, pl. 35, fig. 2.
Volutopsius beringi Dall, 1921, p. 89.—Oldroyd, 1927, pt. 1, p. 186.
Volutopsius beringi kobelti Dall, 1921, p. 89.—Oldroyd, 1927, pt. 1, p. 187, pl. 23, fig. 2.

Eleven living specimens were dredged at 9 stations: 1 (49.2 mm. high) at 40 feet at Eluitkak Pass on Aug. 10, 1948; 1 (25 mm. high) at 120 feet on Aug. 8, 1949; 1 (20 mm.) at 152 feet; 2 (29.2 mm. and 32.7 mm.) at 184 feet; 3 (38.8 mm., 45.7 mm., and 64.8 mm.—the largest living one collected) at 216 feet; 1 (10.8 mm.) at 217 feet; and 2 (24.6 mm. and 45.2 mm.) at 522 feet. Several dead shells ranging from 21.4 to 73 mm. in height were taken from depths of 80 to 453 feet. The one dead shell from 80 feet was inhabited by a hermit crab *Pagurus trigonocheirus*. Another dead shell, apparently a typical *B. beringi*, from 453 feet measures 123 mm. in height even without the missing nucleus; it is about 64 mm. in diameter. Even in the living shells, the whorls of the spire are eroded and the periostracum is missing, but the major portion of the last whorl is covered by a thin, straw-colored periostracum.

OTHER MATERIAL EXAMINED: Over 40 specimens (under the name of *Volutopsius beringi kobelti* Dall) from localities ranging from Icy Cape to the Shumagins.

DISCUSSION: I did not have access to the type of *B. beringi*, which is in the Academy of St. Petersburg, but study of the literature and of at least 50 specimens convinces me that *V. kobelti* Dall (1902) is only a variety of *B. beringi*. About one-third of the specimens labeled *V. kobelti* in the U. S. National Museum are undoubtedly

B. beringi, but there is so much variation, with all types of intergradations between the typical and the var. *kobelti*, that it is impossible to separate some of them. (Middendorff named his species after the explorer Bering. Under the impression that the latter's name was spelled with an "h," he originally wrote *T. Behringii* but later changed it to *T. Beringii* and in a footnote (1851, p. 224) explained that he had learned Bering spelled his name without an "h.")

Typically, var. *kobelti* has a thinner shell, longer spire, shorter aperture, and more curved canal than *B. beringi*. Also, var. *kobelti* has a tendency toward 7 definite sides (pl. 12, fig. 6), whereas *B. beringi* is not so angular (pl. 12, fig. 1) and the last whorl is more tumid than in var. *kobelti*.

The specimens from Point Barrow include typical *B. beringi*, typical var. *kobelti*, and every possible combination of characteristics in between. Some are seven-sided, others six-sided; some have prominent ribs and concave sides; others have obsolete ribs and convex sides; while in others the sides are almost flat. Dall's original description states: "The axial waves (they can hardly be called ribs) of *V. kobelti* are feeble and irregular. . . ." Whether waves or ribs, they are certainly not feeble in some of the specimens. In some the spire is long and slender, with whorls increasing gradually in size; in others it is short and the whorls increase rapidly (pl. 12, fig. 3). In some shells the aperture is longer than the remainder of the shell (pl. 12, fig. 3); in others it is shorter; and in still others the aperture and the remainder of the shell are about equally long.

The variations in the nucleus are remarkable (pl. 12, cf. fig. 4 with figs. 5, 6): In some shells the nuclear whorls number only about 1.75, while in others there are more than 3 whorls; the diameter of these nuclear whorls varies from relatively small to very large; the whorls may increase rapidly in size or, in a nucleus of about 3 whorls, they may all be approximately the same diameter. The length of the nuclear whorls varies as much as the diameter and as much as the length of the postnuclear whorls.

In a specimen from Eluitkak Pass the spire is short (19 mm.), the aperture long (30 mm.); there are two small, short, nuclear whorls, and the postnuclear whorls are short and tumid. Most of these characteristics are like those of *B. beringi*, but the shell is thin, as in var. *kobelti*. In a shell from 341 feet the aperture is 15 mm. long, the remainder of the shell 15.5 mm., the 2.5 nuclear whorls are slightly tapered (the first whorl being 5 mm. in diameter, the next, 6 mm.), and the postnuclear whorls increase gradually in size. In still another shell (medium thin) from 522 feet, the aperture is 22 mm., the remainder of the shell is 23.5 mm., the 3+ nuclear whorls are very large and long and are approximately equal in diameter; the first

postnuclear whorl increases very little, the next slightly more, and the next still more, but the increase is not rapid.

Spiral lirations, varying from faint to strong, are present on the last whorl and sometimes on earlier whorls. The large empty shell from 453 feet (pl. 12, fig. 1), which conforms with the type of *B. beringi* figured by Middendorff (1849c and 1949d, pt. 2, figs. 5, 6), has been tunneled by other animals and is practically covered with colonies of bryozoans, but in one bare spot four faint lirations are visible on the last whorl and at least two on the next to the last whorl. Without the nucleus, this shell has about 5.5 moderately convex whorls, the last increasing more rapidly than the others, with 9 longitudinal waves on the next to the last whorl. I believe that only in young specimens or specimens that have been worn smooth would Dall's statement that "*V. beringi* is absolutely smooth, except at the canal," hold true. Often specimens of var. *kobelti* have lirations as faint as those of true *B. beringi*.

The thin, straw-colored to olive-tan periostracum sometimes covers practically the entire shell, sometimes it is lacking entirely, but more often, even in immature specimens, it is present in patches, the last whorl usually being more thoroughly covered than the others.

DISTRIBUTION: Point Barrow to Nunivak Island and the Shumagins. The var. *kobelti* is new to Arctic Alaska. Four specimens of var. *kobelti* from the beach near Icy Cape and a juvenile from between Cape Lisburne and Cape Beaufort have apparently not been recorded in the literature; nor, apparently, have two young specimens of *B. beringi* from the Shumagins, a large one from Pavlov Bay, and a large shell from the beach at Point Barrow.

Genus *Colus* Röding, 1798

Colus spitzbergensis (Reeve, 1855)

Fusus spitzbergensis Reeve, 1855, p. 395, pl. 32, fig. 6.

Colus spitsbergensis Oldroyd, 1927, pt. 1, p. 212, pl. 4, fig. 7.

Colus spitzbergensis Morris, 1947, p. 153, pl. 36, fig. 8; 1951, p. 202, pl. 36, fig. 8; 1952, p. 126, pl. 29, fig. 5.—Abbott, 1954, p. 229, fig. 51h.

Eleven specimens, at least 9 of which were living, were collected: 2 from 125 feet, 1 from 152 feet, 1 from 217 feet, 1 from 341 feet, 2 from 420 feet, 2 from 438 feet, and 1 from 522 feet. The largest, from 522 feet, measures 64.7 mm. in height by 29.2 mm. in diameter; the smallest, from 217 feet, is 11.7 mm. in height.

The periostracum of the posterior whorls of these shells is largely worn off and often the cords are partially eroded away. The grooves between the cords are usually occupied by several species of foraminifers, bryozoans, and young barnacles.

OTHER MATERIAL EXAMINED: About 10 specimens from Labrador, the Grand Banks, Greenland, the Gulf of St. Lawrence, and Egg Harbor, Maine; about 50 specimens from localities ranging from Icy Cape, Bering Island, the Pribilofs, the Aleutians, and northern Japan.

DISCUSSION: There are variations in the length of the aperture and canal in relation to the length of the spire, in the convexity of the whorls, in the degree of flaring of the mouth, in the thickness of the shell, and in the width of the interspaces as compared with the spiral ridges. One specimen from the Chamisso Islands, Kotzebue Sound, is very slender; in several from Bering Island the whorls are unusually convex; in one from the Shumagins the interspaces are wide; three from off Cape Seniavine have heavy shells, and in two of these the whorls are unusually tumid; and one from the Grand Banks has a longer aperture and canal than usual.

DISTRIBUTION: Point Barrow to Juan de Fuca Strait, Washington; northern Japan; Labrador to Egg Harbor, Maine.

Colus capponius Dall, 1919

Colus capponius Dall, 1919b, p. 317; 1925, p. 12, pl. 3, fig. 2.—Oldroyd, 1927, pt. 1, p. 217, pl. 9, fig. 2.

One shell, measuring 43.5 mm. high by 27.5 mm. in diameter, was taken on Oct. 11, 1949, at a depth of 341 feet, from a bottom of rocks and stones and a small amount of gravel. Although this was an empty shell, it had been alive quite recently. Several species of bryozoan colonies and some foraminifers were growing on the shell. In patches over the shell and over the entire surface of the apical whorls, the periostracum and outer layer of the shell were worn off.

OTHER MATERIAL EXAMINED: Several specimens from Point Barrow and Bering Strait.

DISTRIBUTION: Point Barrow and Bering Strait. It has not been reported previously from any locality except near Port Clarence, Bering Strait.

Colus martensi (Krause, 1885)

Sipho martensi Krause, 1885b, p. 287, pl. 18, fig. 18.
Colus martensi Oldroyd, 1927, pt. 1, p. 222, pl. 28, fig. 6.

On Aug. 10, 1948, a recently dead shell was dredged at 40 feet at Eluitkak Pass to Elson Lagoon, on a bottom predominantly stony, with some mud. The shell, which was occupied by a hermit crab, *Pagurus trigonocheirus*, measures 46 mm. high by 18.5 mm. in diameter, but both ends and the lip are somewhat broken. The shell is medium brown and, like many of the Arctic shells, shows the marks of more than one injury to the lip as it was growing.

OTHER MATERIAL EXAMINED: A few specimens from Cape Shelag-skoi (70th parallel), Metschigne Bay, Bering Strait, and Plover Bay.

DISTRIBUTION: Point Barrow to Plover Bay. It has not been reported previously from north of Bering Strait.

Genus *Neptunea* Röding, 1798

Neptunea ventricosa (Gmelin, 1790)

PLATE 14, FIGURES 1-6

Buccinum saturum Martyn, 1784, pl. 2, fig. 47. [Not binomial.]

Buccinum ventricosum Gmelin, 1790, p. 3498.

?*Chrysodomus variciferus* Dall, 1907, p. 154.

Chrysodomus saturus Dall, 1921, p. 97.—Oldroyd, 1927, pt. 1, p. 232, pl. 27, figs. 3, 4.

?*Chrysodomus solutus variciferus* Dall, 1921, p. 97, pl. 9, figs. 6, 7.

Neptunea ventricosa Abbott, 1954, p. 230, pl. 24s.

Fifteen living specimens were dredged: 1 (48.5 mm. high by 28 mm. in diameter) at 110 feet; 1 (68.5 by 41 mm.) at 120 feet; 1 (16.5 by 10 mm.) at 138 feet; 1 (61.5 by 36.5 mm.) at 125 feet; 3 (21, 25, and 29 mm. high) at 152 feet; 2 (41 and 59 mm.) at 341 feet; 3 (about 79 by 46, 83 by 47, and 83.5 by 44.5 mm.) at 420 feet; 2 (61 mm. and about 78 mm.) at 453 feet; and 1 (24 by 14 mm.) at 522 feet. Several broken and barnacle-encrusted shells inhabited by hermit crabs were taken at 120, 130, and 420 feet. More often than not, the nucleus of a large living shell would be broken off.

OTHER MATERIAL EXAMINED: Numerous specimens from localities ranging from Cape Smythe (Point Barrow), Alaska, to the northern end of Nunivak Island.

DISCUSSION: In some of the shells of this species the whorls are practically flat (pl. 14, fig. 1), in others there is a slight convexity (pl. 14, fig. 5); in most of the shells 2 cords, or carinae, follow the whorls (pl. 14, figs. 1, 6), but in some the more posterior of the two is not marked; in some the last whorl is somewhat lamellose (pl. 14, fig. 3), in others not, and in still others axial ribs (pl. 14, fig. 5) occur at the points of growth cessation. In some of these shells there is only a slight tendency toward nodes, in others there are decided nodes, especially on the more anterior of the 2 carinae. Except in the smallest shells, the outer lip is not angled at the carina. The canal is decidedly curved and reflexed. The color varies from an ashen white to a light brown, sometimes with a combination of colors in the same shell. The carinae are usually darker than the remainder of the shell and the nodes may be still darker or almost white. The throat varies from almost white to purplish brown. In young shells and well-preserved older specimens, the nucleus is markedly conspicuous; it consists of 2 complete whorls, is pure white, large, cylindrical, and blunt. The contrasting color and cylindrical shape cause the nucleus to resemble a plug inserted into the shell.

In 1907 Dall described a *Chrysodomus variciferus*, which was characterized by having "about seven sharp, thin, very prominent varices" on the last whorl. In 1921 he listed this same species as *Chrysodomus solutus variciferus*. Since Hermann (1781) devotes the greater portion of his description of *Buccinum solutum* to stressing the varices of his species (although they were irregularly spaced rather than evenly spaced as in Dall's species), it is difficult to understand why Dall assigned a form with varices to a subspecies of *N. soluta*, the chief characteristic of which was its varices. One can only suppose that he confused *N. soluta* and *N. satura* and intended making *varicifera* a subspecies of *N. satura*. This is equally difficult to understand, for it is well known that specimens of *N. "satura"* are often lamellose. (See remarks under *Neptunea middendorffiana*.)

DISTRIBUTION: Point Barrow southwest to Bering Strait, and Plover Bay, Siberia, southeast to Cape Douglas (about lat. 65° N., long. 167° W.), Alaska.

Neptunea heros (Gray, 1850)

PLATE 15

Tritonium (Fusus) antiquum var. *communis obsoletior*,* forma *normalis* Middendorff, 1849d, pt. 2, p. 461 (=p. 132 of 1849c), pl. 2, figs. 1, 2; 1851, vol. 2, pt. 1, p. 228, pl. 9, figs. 1, 2.

Tritonium (Fusus) antiquum var. *communis insignior* Middendorff, 1849d, pt. 2, p. 462 (=p. 133 of 1849c), pl. 5, figs. 3-6 (figs. 3, 4 are of younger specimens).

Tritonium (Fusus) antiquum var. *communis obsoletior* forma *normalis*, *apertura alta* Middendorff, 1851, vol. 2, pt. 1, p. 228, pl. 9, figs. 3, 4.

Tritonium (Fusus) antiquum var. *communis insignior* forma *elatior* Middendorff, 1851, vol. 2, pt. 1, p. 228, pl. 8, fig. 1.

Tritonium (Fusus) antiquum var. *communis insignior* forma *normalis* Middendorff, 1851, vol. 2, pt. 1, pl. 8, fig. 2.

Chrysodomus heros J. Gray, 1850, p. 15, pl. 7.

Fusus fornicatus Reeve, 1843-1878, vol. 4, *Fusus*, pl. 16, fig. 63.

Chrysodomus satureus communis Dall, 1921, p. 97.—Oldroyd, 1927, pt. 1, p. 235.

Chrysodomus solutus Dall, 1921, p. 97 (in part).

Eleven living specimens were dredged: 3 (47 by 28 mm., 77 by 45.5 mm., and 96 by 52 mm.) at Eluitkak Pass; 2 (24 and 27 mm. in height) at 120 feet; 1 (73 by 46.5 mm.) at 130 feet; 1 (74.5 by 45 mm.) at 138 feet; 2 (64 by 35 mm. and 106 by 55.5 mm.) at 522 feet; and 2 (89 by 48 mm. and 100 by 54 mm.) at 741 feet. Eleven often badly broken and barnacle-encrusted shells, usually inhabited by hermit crabs, were dredged at 152, 184, 295, 341, 438, 741 feet, and at Eluitkak Pass.

OTHER MATERIAL EXAMINED: Specimens in the collection of the U. S. National Museum from localities ranging from Point Barrow to Siberia and to Nunivak Island and the Pribilofs.

* Middendorff (1851b, p. 226) calls attention to a printer's error on page 131, line 23, of his "Beitrag" [1849c—equals p. 460, 1849d], in which "*communis elatior*" appeared instead of "*communis obsoletior*."

DISCUSSION: Middendorff (1849c,d) described several species of *Neptunea* as sub-subvarieties of *Tritonium antiquum*. His polynomial system is outlined below:

Tritonium antiquum Linnaeus

Section I. Non carinate, without nodes.

1. Var. *originalis* nob.

2. Var. *behringiana* nob. [Middendorff's pl. 2, figs. 3, 4; pl. 5, fig. 1]

Section II. Carinate.

3. Var. *communis* nob.

1) Var. *communis obsoletior*

forma *normalis* [Middendorff's pl. 2, figs. 1, 2]

forma *elatior* [Middendorff's pl. 5, fig. 2]

forma *normalis*

forma *normalis, apertura alta* [Middendorff's pl. 2, figs. 1, 2]

2) Var. *communis insignior* [Middendorff's pl. 5, figs. 5, 6]

3) Var. *angulato-carinata*

Like the buccinums, the neptuneas are extremely variable, so variable as to make the separation of specimens into species discouragingly difficult. Middendorff's polynomial system was no doubt the result of an attempt to give names to these varied forms.

As J. E. Gray (1850) was apparently the first person after Middendorff to describe this species, I am using his name for it.

Although in his reference for *Chrysodomus saturus communis* Middendorff, Dall (1921) designates the correct figures (pl. 5, figs. 5, 6 of Middendorff, 1849c,d), he apparently later confused *N. satura* and *N. soluta*, for he included shells of *Neptunea heros* under the label of "*Chrysodomus solutus* Hermann" (see *Neptunea middendorffiana* below).

The shell of *Neptunea heros*, consisting of 5 whorls plus about 2 nuclear whorls, is sturdy, varying in color from ashen to tan and the latter color may tend toward a rosy cast or toward an olive tan. The throat is usually white but in some specimens the white coating is too thin to conceal the tan of the shell. The majority of the shells (pl. 15) tend to be less ventricose than those of *N. ventricosa* (pl. 14, figs. 1-6) and more ventricose than those of *N. middendorffiana* (pl. 14, figs. 7-10). The canal is longer and less curved than that of *N. ventricosa*, and tends to be somewhat more curved than in the majority of *N. middendorffiana*. Although in all three species there is a tendency toward the formation of longitudinal ridges and varices at the points of growth cessation, this tendency appears to be less marked in *N. heros* than in *N. ventricosa*. The single carina or cord that follows the whorls is usually noded. In the long-spined forms this cord is situated about the middle of the whorl (pl. 15, fig. 1) but in the short-spined forms it is closer to the anterior end of the whorl (pl. 15, fig. 2). The nodes may project prominently or may be

elongated (pl. 15, fig. 2) and the cord may practically disappear on the last portion of the last whorl, its location being indicated only by a slight shouldering and by the nodes (pl. 15, fig. 7). An unusually slender form with a very weak carina and without nodes is shown in pl. 15, fig. 4. In the shortest-spined forms the aperture may be nearly twice as long as the remainder of the shell (pl. 15, fig. 2). In contrast to the nucleus of *N. ventricosa* and of *N. middendorffiana*, that of *N. heros* is small and tapered.

DISTRIBUTION: MacKenzie River delta west and south to Bristol Bay in the Bering Sea. Point Barrow is a new locality.

Neptunea middendorffiana, new name

PLATE 14, FIGURES 7-10

Tritonium (Fusus) antiquum var. *communis obsoletior* forma *elatio*r Middendorff, 1849d, pt. 2, p. 461, pl. 5, fig. 2.

Chrysodomus solutus Dall, 1907, p. 154 (in part).—Oldroyd, 1927, pt. 1, p. 236 (in part). (Not *Buccinum solutum* Hermann, 1781, pp. 52, 53, pl. 2, figs. 3, 4.)

Neptunea despecta Y. Hirase, 1907, p. 360 (in part). (Not *Murex despectus* Linnaeus, 1758.)

Neptunea vinosa (Dall), var., Kinoshita and Ishaya, 1934, p. 9, pl. 6, fig. 43. (Not *Chrysodomus vinosus* Dall, 1919.)

Neptunea soluta Kuroda, 1936, p. 185.—Kira, 1954, p. 55, pl. 27, fig. 18. (Not *Buccinum solutum* Hermann, 1781.)

Shell medium for the group, slender, with 6.25 gradually expanding whorls, including 2 nuclear whorls. External surface of shell reddish brown, with fine grayish white longitudinal lines corresponding to the incremental lines. Interior of aperture whitish, porcellaneous, banded with brown at margin of external lip. Nuclear whorls broad, white. Whorls of the shell characterized by a keel at the shoulder, the keel beginning faintly on the first postnuclear whorl and becoming increasingly heavier on the anterior whorls, located about two-thirds the distance anterior to the suture, darker than the remainder of the shell, with weak blunt or elongated nodules irregularly spaced. Sutures appressed. Aperture fairly narrow; external lip angular. Columella nearly straight, parietal wall brown, internal lip white; anterior canal short, moderately wide, and only slightly reflexed. Nucleus brown, with grayish white incremental lines, showing 9 or 10 major growth interruption lines.

DIMENSIONS: Holotype: height, 68.3 mm.; diameter, 40 mm.; angle of spire, 57°.

TYPE LOCALITY: About 4 miles off Point Barrow base, Alaska. Depth, 175 feet. Bottom: gravel, small stones (haul containing sea urchins—*Strongylocentrotus drobachiensis*). Collected by G. E. MacGinitie, Oct. 14, 1949.

REPOSITORIES: Holotype, U. S. National Museum, No. 602,694. Paratypes, U. S. National Museum, Nos. 606,132 (2); 606,136 (1); 606,141 (1); 606,142 (3); 606,144 (3); 606,146 (3). Other paratypes in the collections of the California Academy of Sciences, Stanford University, and Zoological Museum, Copenhagen.

OTHER LOCALITIES: Specimens in the U. S. National Museum from the Arctic Ocean and Bering Sea. Also from northern Japan.

REMARKS: In addition to the type, 13 living specimens were dredged: 1 (66.5 by 37 mm) at Eluitkak Pass; 1 (39 by 20.5 mm.) at 125 feet; 1 (48 by 25 mm.) at 130 feet; 1 (65 by 35 mm.) at 150 feet; 4 (55 by 30, 55 by 31, 49 by 27, and 28.5 by 16 mm.) at 152 feet; 1 (69 by 38 mm.) at 184 feet; 3 (43.5 by 36, 63 by 32, and 68 by 38 mm.) at 420 feet; and 1 (39+ mm. long) at 438 feet. A few more or less broken shells inhabited by hermit crabs were dredged at Eluitkak pass, 110, 125, 130, and 150 feet.

In some specimens of this species from Point Barrow the keel is approximately in the middle of the whorl (pl. 14, fig. 10), and in one or two specimens it is closer to the posterior end of the whorl than to the anterior (pl. 14, fig. 7 shows a specimen in which it is slightly nearer the posterior end). In one specimen (pl. 14, fig. 10) the nodules on the last whorl are rather marked. Some specimens lack the brown border along the inner margin of the external lip, and in immature specimens the entire throat is usually brownish. On the last whorl, especially on the last quarter turn, a few shells develop irregularly spaced longitudinal ridges (pl. 14, fig. 10); in such shells the canal, relatively straight in the majority of the shells, is somewhat curved and reflected.

This species differs from *N. heros* and *N. ventricosa* in its consistently darker color and slender shape, in its shorter and narrower aperture, in its straighter columella, and in its shorter, narrower, and generally less reflexed canal. The nucleus is less tapered than that of *N. heros* but usually not so cylindrical as that of *N. ventricosa*. The operculum tends to be narrower than that of either of the above species.

This species is named in honor of A. Th. von Middendorff, who probably first collected an example of the species and who worked on the difficult Arctic neptuneids.

DISCUSSION: Since Middendorff's polynomial designation is not acceptable and since Hermann's *Buccinum solutum* (1781) is a *Buccinum* and not a *Neptunea* as Dall (1907) thought, it is necessary to assign another name to this species.

The shell described by Hermann was purchased at an auction in Paris several years prior to the publication of his description and no locality was given. The shell (pl. 27) is obviously a lamellose speci-

men of *B. undatum* Linnaeus that had, as Hermann repeatedly stresses, grown irregularly as the result of untoward circumstances.

As Dall (1921) cites page 53 of Hermann (1781) for *Buccinum solutum* Hermann instead of page 52, where Hermann's description begins, it is possible that he read for the description the next one after *B. solutum*. In the collections of the U. S. National Museum, Dall identified and labeled as *Chrysodomus solutus* (Hermann) specimens of both *Neptunea heros* (see preceding species) and *N. middendorffiana*. A search of the literature fails to reveal any illustration of "*Chrysodomus solutus* (Hermann)" by Dall, but his conception of it has found its way into Japanese literature, as evidenced by Kuroda (1936)¹⁰ and Kira (1954), the obvious explanation being that Dall either identified specimens for some Japanese worker or that a Japanese visitor at the U. S. National Museum got his ideas from specimens labeled by Dall.¹¹

It is here suggested that "*Neptunea soluta* (Hermann)" be dropped from our list of western shells and that *B. solutum* Hermann fall as a homonym of *B. undatum* Linnaeus.

Although the shells of *Neptunea* were easily separable into the three species given herein, there remains the possibility that *N. middendorffiana* may be the male of another species. On the basis of the nucleus, *N. middendorffiana* shows closer affinity to *N. ventricosa* than to *N. heros*. By the time the problems involving *Neptunea* arose, I did not have available the soft parts with which to make determinations of sex.

Genus *Plicifusus* Dall, 1902

Plicifusus kroyeri (Möller, 1842)

PLATE 10, FIGURES 11-13

Fusus kroyeri Möller, 1842a, p. 18; 1842b, p. 91.—Kobelt, 1887, p. 85, pl. 15, figs. 1-3.

? *Fusus verkruzeni* Kobelt, 1876, p. 70, pl. 2, fig. 1.

Sipho kroyeri Tryon and Pilsbry, 1879-1898, vol. 3, p. 130, pl. 53, figs. 333-336.

Plicifusus verkruzeni Oldroyd, 1927, pt. 1, p. 208.

Plicifusus kroyeri Oldroyd, 1927, pt. 1, p. 206.—Morris, 1952, p. 127, pl. 29, fig. 2.

Twelve living specimens were dredged: 1 (30.5 mm. in height) from 120 feet (Sept. 15, 1948); 3 (50, 55.3, and 57 mm. in height) from 125 feet; 1 (28.8 by 14.5 mm.) from 130 feet (Sept. 15, 1948); 4 (40.4 by 16.6 mm., 40.4 by 20 mm., 42.3 by 18 mm., and 48.1 by 19 mm.)

¹⁰ For several of these Japanese references I am indebted to Dr. Katura Oyama.

¹¹ Since this was written, Dr. Oyama has informed me that it is his understanding that Dr. Dall identified some specimens for the late Y. Hirase and that Kuroda, successor to Hirase, followed Dall's identification and that Kuroda identified the specimen reported by Kinoshita and Isahaya and the one figured by Kira.

from 184 feet; 1 (15.7 by 7.1 mm.) from 341 feet; and 2 (44.6 by 17.6 mm., and 52.7 by 22 mm.) from 420 feet. The largest specimen is a dead shell, measuring 69.3 mm. in height, from 150 feet.

Some of the living shells had the usual quota of foraminifers and small barnacles, and in several there were large areas covered with colonies of bryozoans.

OTHER MATERIAL EXAMINED.—Three specimens from Point Barrow and the "Arctic Ocean," several specimens (labeled *P. verkruzeni*) from Icy Cape, Cape Prince of Wales, Bering Strait, Plover Bay, and Queen Charlotte Sound, British Columbia; about 25 specimens from the Grand Banks, Green Bank, Labrador, and the Gulf of St. Lawrence.

DISCUSSION: The greatest variations in the specimens from Point Barrow, as well as in those from other localities, are in the strength of the axial ribs (see pl. 10, figs. 11–13), which range from those that are practically obsolete through medium to stout, and in the proportion of the length of the aperture to the remainder of the shell. The latter variation is shown in table 3. The 2 specimens from 341 feet have only weak folds near the sutures (as in Tryon and Pilsbry, vol. 3, pl. 53, fig. 336); the dead shell from 150 feet has prominent, stout ribs (loc. cit., pl. 53, fig. 335); others have ribs that are intermediate in strength (loc. cit., pl. 53, fig. 334); and still others may have stout, prominent ribs on the apical whorls and only faint ones on the body whorl. Some shells are twice as thick or heavy as others of comparable size. The throat varies from a deep buff to white faintly tinged with light buff.

Several of the Point Barrow specimens correspond with those that Dall identified as *P. verkruzeni* (Kobelt). However, Dr. Thorson, who examined about half of them on his recent visit to the West Coast, says that they correspond fully with varieties of *P. kroyeri* in the Danish collections from Greenland, and Tryon and Pilsbry illustrate a relatively smooth form of *P. kroyeri*. In his description of *P. verkruzeni*, Kobelt speaks of an ovately turreted, almost smooth shell, with a very short, solid canal. His description was based on two specimens brought back by Verkrusen from Porsangen Fjord in

TABLE 3.—Comparison of length of aperture and remainder of shell in specimens of *Plicifusus kroyeri*

Shell	Length of aperture (in mm.)	Length of, remainder of shell
1. Adult, with stout ribs	25.2	25.0
2. Immature, with stout ribs	14.5	15.7
3. Adult, with stout ribs on apical whorls, weak on last whorl	27.7	31.4
4. Adult, smooth form with weak folds on apical whorls	19.7	26.0
5. Similar to No. 4	22.2	30.2

northern Norway. Inasmuch as no other specimens of *P. verkruzeni* seem to exist and in view of the lack of conflict between the description of *P. verkruzeni* and certain forms of *P. kroyeri*, it is possible that the former is merely a smooth, slender form of *P. kroyeri*.

DISTRIBUTION: Burch (1945, No. 50, p. 16) gives the Pacific range of *P. kroyeri* as Point Barrow to Vladivostok, Gulf of Peter the Great, the Japan Sea, and the east coast of Siberia [and there are specimens in the U. S. National Museum from British Columbia]; and Thorson (1944) gives the Atlantic range as Parry Island to Labrador, Newfoundland to Cape Cod, Greenland, Jan Mayen, and Spitzbergen.

Genus *Volutopsius* Mörch in Rink, 1857

An orange-brown, thimble-shaped, empty capsule of some species of *Volutopsius* washed ashore on Oct. 21, 1949. The capsule is 22 mm. long by 21 mm. in diameter, large enough to belong to *V. stefanssoni*.

Volutopsius stefanssoni Dall, 1919

PLATE 12, FIGURE 7

Volutopsius stefanssoni Dall, 1919c, p. 22, pl. 1; 1921, p. 89, pl. 9, fig. 2.—Oldroyd, 1927, pt. 1, p. 187, pl. 16, fig. 9; pl. 19, fig. 2.

Two specimens were taken: one, a dead shell with 4.5 whorls, including the nucleus, taken at a depth of 110 feet (Sept. 8, 1948), is 62 mm. high by 35 mm. in diameter (pl. 12, fig. 7); the other, a live specimen with 5.5 whorls, a brown throat and a white pillar, and partially covered with a thin, medium-brown periostracum, taken at Eluitkak Pass (40 feet, on Aug. 10, 1948), is about 75 mm. high by about 42 mm. in diameter.

OTHER MATERIAL EXAMINED: 13 specimens from the Sea Horse Islands, Plover Bay, near Nunivak Island, and near the Pribilofs.

DISCUSSION: Some of these shells have a much longer spire in relation to the length of the aperture than do others. In some the whorls are somewhat flat rather than inflated, and the shoulder is rounded in some and almost angular in others. In some the "obscure swellings at the shoulder" are quite pronounced. One from near the Pribilofs has a yellowish tan periostracum.

DISTRIBUTION: Point Barrow, the type locality, southward to the 57th parallel.

Family FUSINIDAE

Genus *Ptychatractus* Stimpson, 1865*Ptychatractus occidentalis* Stearns, 1871

PLATE 5, FIGURE 10

Ptychatractus occidentalis Stearns, 1871, p. 1.—Dall, 1921, p. 87, pl. 6, fig. 8.—Oldroyd, 1927, pt. 1, p. 175, pl. 7, fig. 1.

Eight living specimens were dredged: 3 (averaging about 24 mm. high) from 341 feet; 2 (28.3 and 30.3 mm. high) from 438 feet; and 3 (from 15.8 by 7.5 mm. to 22.1 by 10.7 mm.) from 453 feet. Four shells were washed ashore and 8 shells were dredged from depths of 152 to 741 feet. Most of the dead shells were broken and encrusted with bryozoans and barnacles.

OTHER MATERIAL EXAMINED: The type, from the Shumagins, and 3 other specimens from the Shumagins, Bering Island, and Iliuliuk, Unalaska.

DISCUSSION: The specimens from Point Barrow are larger than those examined from more southerly waters.

This species is closely allied to *P. ligatus* (Mighels and Adams) from the western Atlantic, differing from the latter in the following respects: More numerous ridges (from 10 to 11 on the body whorl as compared with about 7 in *P. ligatus*); wider ridges and narrower grooves; rounded ridges in *P. ligatus*, usually flat and squarely cut down to the grooves in *P. occidentalis*. In the larger specimens of *P. occidentalis* the ridges may be somewhat rounded, but they are not narrow as in *P. ligatus*.

DISTRIBUTION: Point Barrow southward to about the 57th parallel of latitude. It is new to Arctic Alaska.

Suborder TOXOGLOSSA

Family CANCELLARIIDAE

Genus *Admete* Möller, 1842*Admete couthouyi* (Jay, 1839)

And varieties

PLATE 2, FIGURES 1-3

Cancellaria buccinoides Couthouy, 1838, p. 105, pl. 3, fig. 3. [Preoccupied.]

Cancellaria couthouyi Jay, 1839, p. 77.—Gould, 1841, p. 283, fig. 190.

Admete crispa Möller, 1842a, p. 15.

Cancellaria (*Tritonium*) *viridula* Middendorff, 1849d, vol. 6, pt. 2, p. 439, pl. 9, figs. 13, 14 [= var. *laevior* Leche]; pl. 10, figs. 1, 2 [= varieties]; pl. 10, figs. 3, 4.

Admete couthouyi var. *laevior* Leche, 1878, new ser., vol. 16, p. 48.

Admete middendorffiana Dall, 1885a, vol. 7, p. 524.

Cancellaria (Admete?) middendorffiana Dall, 1886, vol. 9, p. 297.

Cancellaria middendorffiana Dall, 1902, vol. 24, p. 516, pl. 38, fig. 6.

Admete couthouyi Oldroyd, 1927, pt. 1, p. 157, pl. 16, fig. 2.—Grant and Gale, 1931, p. 622.—Morris, 1952, p. 144, pl. 30, fig. 11.

Five living specimens were collected: 1 (14.5 by 8 mm.) at Eluitkak Pass; 1 (15.4 by 8.9 mm.) at 162 feet; 1 (17.3 by 9.9 mm.) at 295 feet; and 2 (14 by 7.8 mm., and 14 by 7.9 mm.) at 341 feet. Two empty shells were taken: 1 (18.8 by 11.9 mm.) at 80 feet (Aug. 21, 1948); and 1 (9.9 by 6.6 mm.) at 741 feet.

OTHER MATERIAL EXAMINED: About 75 specimens (labeled *A. middendorffiana*) from localities ranging from Dease Inlet south to Nuni-vak Island, Alaska; about 80 specimens (labeled *A. couthouyi*) from localities ranging from the Sea Horse Islands, Alaska, to Point Loma, Calif.; about 30 specimens (labeled *A. couthouyi*) from localities ranging from Labrador, Newfoundland, and Maine to Massachusetts; and 12 specimens from Finmark and Vadsø, Norway.

DISCUSSION: Time did not permit the exhaustive study necessary for determining with absolute certainty that *A. middendorffiana* is merely a variety or form of *A. couthouyi* but it is reasonably certain. Grant and Gale (1931) consider *A. middendorffiana* a low-spined form of *A. couthouyi*. Certainly there are many individuals that could as easily be assigned to one as the other species. If these are distinct species, as seems highly doubtful, then there are specimens of *A. middendorffiana* on the East Coast. A specimen from the Gulf of Maine has very weak axial ribs, is somewhat tumid, and has spiral sculpture resembling that of *A. middendorffiana*. Another specimen from Newfoundland has the short spire and tumid body of *A. middendorffiana*, but with the ribbing and spiral sculpture more closely resembling those of *A. couthouyi*. Six specimens from Labrador are all characterized by weak axial ribbing, but four of them have a long spire and the other two have a short spire and are somewhat tumid. Some of the specimens from the West Coast that are labeled *A. couthouyi* have weak ribs, a short spire, and flat, spiral bands with narrow interspaces. Others from the same locality have the axial ribs almost lacking, a long spire, and narrow spiral cords with interspaces wider than the cords.

There are all combinations of short to long spires, slenderness to obesity, axial ribs varying from prominent and sharp to those scarcely perceptible at the sutures, and of narrow spiral threads with wider interspaces to flat, spiral bands with interspaces narrower than the bands.

Several specimens from off southern California have prominent axial ribs and spiral cords that cause the shells to be nodulous. All of the specimens from Norway have a long, pointed spire, and the majority

are nodulous. The specimens from the east coast of North America tend to be smaller than those from the Alaskan Arctic.

One of the shells from Point Barrow (from 80 feet) is like a typical *A. middendorffiana* (pl. 2, fig. 1), that is, with a short spire, whorls rapidly increasing in size, with an obese body whorl, and weak axial plications anterior to the suture. The two young specimens from 341 feet (pl. 2, fig. 2) have a spire like that of *A. couthouyi*, that is, with strong axial ribs and spiral cords, giving a nodulous appearance. The others have a combination of characters of both *A. middendorffiana* and *A. couthouyi* (pl. 2, fig. 3).

It is probable that Dall's *A. middendorffiana* is synonymous with Leche's var. *laevior*, in which event var. *laevior* has priority.

DISTRIBUTION: *Admete couthouyi* is circumpolar: it has been reported from north of Alaska, Canada, Europe, and Siberia, and from many of the major northern islands. It occurs from Alaska south to southern California and to Japan; from Baffin Bay and Greenland south to New England; and from Spitzbergen south to the Faroes.

Admete regina Dall, 1911

PLATE 5, FIGURE 1

Admete regina Dall, 1911, p. 19.—Oldroyd, 1927, pt. 1, p. 156.

A single, very recently empty shell of this species was dredged at 522 feet. It measures 36.6 mm. in height by 22.9 mm. in diameter. The spiral sculpturing is largely worn off.

OTHER MATERIAL EXAMINED: Four beach-worn specimens from Icy Cape and 13 from Cape Prince of Wales, Plover Bay, the Pribilofs, and the Kudobin Islands; 1 specimen from the Gulf of St. Lawrence, 1 from off Beachy Island, Labrador, and 1 young specimen from 101 fathoms from "Chebucto" Head (=Chedabucto? Head, Nova Scotia).

DISCUSSION: Although only 20 specimens were examined, they displayed several variations. The specimen from off Beachy Island, Labrador, and the one from the Gulf of St. Lawrence have mouths that flare less than those of typical specimens; one from off the Kudobin Islands has a less obese body whorl, a more tapered spire, and a relatively longer and less flaring aperture. A shell from Cape Prince of Wales is unusually heavy. Two medium-small specimens from Plover Bay have only 2 or 3 visible columellar plaits instead of 6, and the one from Chedabucto Head has only 4 or 5.

DISTRIBUTION: Point Barrow southward to the Pribilofs and the Aleutians (about lat. 56° N. and long. 161° W.); Labrador to the Gulf of St. Lawrence. Point Barrow is a new locality. This species has not been reported previously from the western Atlantic.

Family TURRIDAE

Some of the generic names, such as *Bela* and *Lora*, formerly used in this family are not available. Several new genera (see Bartsch, 1941) have been erected, but these and the other available generic names do not cover the entire family. Consequently, it is impossible to assign some species to a genus. In this paper, such species have been placed under "*Oenopota*."

Genus *Obesotoma* Bartsch, 1941*Obesotoma tenuilirata* (Dall, 1871)

PLATE 16, FIGURE 1

Bela tenuilirata Dall, 1871, p. 98.

Lora tenuilirata Dall, 1919a, p. 42, pl. 15, fig. 4.

Four specimens were dredged: 1 living specimen (17.4 mm. high by 8.8 mm. in diameter) from 132 feet; 1 living (12.6 by 6 mm.) and 1 dead (12.4 by 6 mm.) from 217 feet; and 1 living (11.4 by 5.5 mm.) from 477 feet. In the specimen from 132 feet the ribs of the apical whorls are more or less eroded and the nucleus is worn but not decorticated.

OTHER MATERIAL EXAMINED: The type, from Norton Sound, and approximately 20 other specimens from localities ranging from Point Barrow to Bristol Bay.

DISTRIBUTION: Point Barrow to Hagemeister Island, and Unimak Island in the Aleutians. Dall (1921) gives the southeastern range as the Shumagins, but I could find no specimens nor records of specimens from east of Hagemeister and Unimak Islands. Johnson (1934) gives the Atlantic range as "off Martha's Vineyard, 365 fathoms."

Obesotoma sp. 1

Four shells were dredged: 1 (14.4 by 7 mm.) from 125 feet; 1 (14.8 by 7.2 mm.) from 213 feet; 1 (9 by 4.5 mm.) from 216 feet; and 1 (15.8 by 7.5) from 149 feet.

DISCUSSION: These specimens correspond to Bartsch's manuscript species No. 227, of which there are 7 specimens (from Plover Bay) in the collection of the U. S. National Museum.

DISTRIBUTION: Point Barrow, Alaska, and Plover Bay, Siberia.

Obesotoma sp. 2

Two living specimens were dredged: 1 (15.1 by 7 mm.) at 130 feet on Aug. 9, 1949; and 1 (14.6 by 6.8 mm.) at 216 feet.

DISCUSSION: These two specimens agree fairly well with Bartsch's manuscript species No. 135, of which there are 3 dead and worn shells

in the collection of the U. S. National Museum. The columellas of the Point Barrow specimens appear straighter than in species No. 135.

DISTRIBUTION: Point Barrow and southward.

Obesotoma simplex (Middendorff, 1849)

PLATE 16, FIGURE 2

Pleurotoma simplex Middendorff, 1849b, p. 19; 1849c, pt. 2, p. 119; 1849d, pt. 2, p. 448; 1851, vol. 2, pt. 1, p. 223, pl. 12, figs. 15, 16.

Bela simplex G. Sars, 1878, p. 239, pl. 17, fig. 4; pl. 23, fig. 11.

Bela ? *laevigata* Dall, 1871, p. 98, pl. 16, fig. 7.

Bela laevigata Dall, 1886, p. 300, pl. 3, fig. 7.

Four specimens were washed ashore: 1 dead (11.6 by 6 mm.) on Sept. 12, 1 living (11.5 by 6.1 mm.) on Sept. 23, 1949; and 2 living (11.6 by 7.2 mm. and 11.7 by 6.3 mm.) on July 26, 1950.

OTHER MATERIAL EXAMINED: The type of *B. laevigata*, from St. Michael, Alaska, 35 specimens from Norton Sound, and 20 specimens from Chirikoff Island; and (labeled *B. simplex*) 2 large specimens from Spitzbergen, 6 (from small to large) from Norway, and 2 large specimens from Russian Lapland.

DISCUSSION: Although Sars examined specimens of this species from the Pacific and identified them as *B. simplex*, Dall believed they were sufficiently different to warrant a new species and he described them as *B. laevigata*. That Sars considered this a highly variable species is shown by his two figures (as listed in the synonymy above). After examining one of the specimens in the MacGinitie collection, Dr. Thorson wrote me that it agrees closely with some of the specimens from eastern Greenland. He added that it is an extremely variable species. Something of the variability in proportions is illustrated by the measurements given above.

Although it was a living specimen, the shell taken on September 12 is deeply pitted and the spire is badly eroded (pl. 16, fig. 2). The outer lip is broken and the shell shows two previous breaks along old lip lines.

DISTRIBUTION: Point Barrow to Chirikof Island (about lat. 55.5° N. and long. 155.5° W.) and the Sea of Okhotsk; and (Thorson, 1944) eastern Greenland, northern and eastern Iceland, Spitzbergen, and northern Norway.

Obesotoma sp. 3

Two living specimens of this species were dredged: 1 (13.7 by 7 mm.) at 341 feet and 1 (11.1 by 5.9 mm.) at 741 feet.

DISCUSSION: These two specimens are the same as Bartsch's manuscript species No. 232, of which there is one somewhat worn specimen (from southeast of Kamchatka) in the collections of the U. S. National Museum.

DISTRIBUTION: Point Barrow, Alaska, to southeast of Kamchatka.

Genus *Oenopota* Mörch, 1852***Oenopota nazanensis* (Dall, 1919)**

PLATE 16, FIGURE 3

Lora nazanensis Dall, 1919a, p. 45, Pl. 15, fig. 8.

Two living specimens were dredged: 1 (10.7 by 6.1 mm.) at 216 feet, and 1 (8.2 mm. high) at 295 feet. The nucleus and ribs of the whorls of the spire are somewhat eroded.

OTHER MATERIAL EXAMINED: One specimen, labeled No. 71. This may be the figured type, since the latter was missing from its vial.

DISTRIBUTION: Dall (1921) gave the range of this species as Norton Sound to the Aleutians, but there is no record of any specimen from north of the type locality, Nazan Bay. The present range is Point Barrow, the Aleutians, Kodiak Island, Elrington Island in Prince William Sound, and Portage Bay (see Burch, 1946, No. 62, p. 17, for collecting data on the latter localities). The Point Barrow specimens extend the range into the Arctic—from the 60th to the 71st parallel of latitude.

***Oenopota tenuicostata* (G. O. Sars, 1878).**

PLATE 16, FIGURE 4

Pleurotoma tenuicostata M. Sars, 1869, p. 259 (nomen nudum).

Bela tenuicostata G. Sars, 1878, p. 237, pl. 17, figs. 1a-b.

A single living specimen, 7.8 mm. in length by 3.7 mm. in diameter, was dredged at 420 feet. The periostracum is worn from the nucleus but the shell is otherwise in excellent condition.

DISCUSSION: Dall (1921, p. 74) cites M. Sars as the authority for this species, but M. Sars (1869) gives only the name without any description or illustration. The description by G. O. Sars (1878) appears to be the first published one.

DISTRIBUTION: Point Barrow, St. Lawrence Island, Nunivak Island, and Safety Cove, Alaska. Johnson (1934) gives the east coast range as Eastport, Maine, to southeast of Nantucket, R. I.; and Thorson (1944) lists eastern and western Greenland, northern and eastern Iceland, Jan Mayen, Spitzbergen, and northern and southern Norway. The Point Barrow specimen extends the range northward from the 60th to beyond the 71st parallel.

***Oenopota harpa* (Dall, 1885)**

PLATE 6, FIGURES 5, 6

Bela harpa Dall, 1885a, p. 523; 1886, p. 300, pl. 4, fig. 2.

Seven living specimens were dredged: 1 (11.8 by 5.5 mm.), through a hole in the ice, at 149 feet; 1 (10.7 by 5.2 mm.) at 152 feet; 1 (10 mm. long, with apex covered with the hydroid *Syncoryne*), through a

hole in the ice, at 162 feet; 2 (14.4 by 6.6 and 15.1 by 6.3 mm.) at 175 feet; 1 (19.1 by 8.8 mm.) at 213 feet; and 1 (10.2 by 5 mm.) at 420 feet. In addition, a dead shell (17.3 by 8.7 mm.) was taken at 110 feet, and another (20.5 mm. long) at 213 feet.

OTHER MATERIAL EXAMINED: Several specimens in the collection of the U. S. National Museum.

DISCUSSION: There is variation in the number of ribs, and in some specimens there is a tendency toward a shoulder, though the latter is more of an effect than an actuality. The description of this species was published in 1885, not 1884 as given by Dall (1921, p. 75).

DISTRIBUTION: Point Barrow south and east to the Queen Charlotte Islands, British Columbia. Dall (1921) says that it is circumboreal, but Johnson (1934) does not list it and European authors do not mention it.

***"Oenopota" elegans* (Möller, 1842)**

PLATE 16, FIGURES 7, 8

Defrancia elegans Möller, 1842a, p. 13; 1842b, p. 86.

Bela elegans G. Sars, 1878, p. 225, pl. 16, fig. 15.

Four specimens were dredged: 1 living (13.3 by 5 mm.) and 1 recently dead (10.8 by 4.3 mm.) at 152 feet; 1 drilled (12.6 by 4.6 mm.) at 175 feet; and 1 living (12.2 by 4.9 mm.) at 204 feet.

DISCUSSION: Dr. Thorson compared these specimens with Möller's type specimens from western Greenland. He says that the one from 204 feet (pl. 16, fig. 8) is a trifle broader than the types, but that the others are quite typical (pl. 16, fig. 7). He adds that, after examining specimens from Iceland, Greenland, and New England, he is inclined to believe that G. Sars' figure (1878, fig. 15 on pl. 16) is of an extreme variant of the species.

DISTRIBUTION: Point Barrow and Blizhni Islands to St. Lawrence Island, Bering Sea; also (Thorson, 1944) Iceland, western Greenland, Spitzbergen, and northern and southern Norway. Point Barrow is a new locality.

***"Oenopota" harpularia* (Couthouy, 1838)**

PLATE 16, FIGURE 9

Fusus harpularius Couthouy, 1838, p. 106, pl. 1, fig. 10.—Gould, 1841, p. 291, fig. 191.

Defrancia woodiana Möller, 1842b, p. 86.

Bela harpularia G. Sars, 1878, p. 234, pl. 23, fig. 10; pl. 16, fig. 17.

Lora harpularia Morris, 1951, p. 22, pl. 39, fig. 6.

A single living specimen (11.4 by 4.9 mm.) was dredged at 130 feet on Aug. 9, 1949. This specimen is white, tinged with creamy buff near some of the sutures and nodes.

DISTRIBUTION: Point Barrow to Puget Sound; and (Thorson, 1944)

Grinnell Land to Labrador, Newfoundland, and Cape Cod, Mass.; northern and eastern Iceland, and northern and southern Norway.

"Oenopota" pyramidalis (Strøm, 1788)

And varieties

PLATE 16, FIGURES 10-13, PLATE 17, FIGURES 6, 7

Buccinum pyramidale Strøm, 1788, p. 297, pl. 1, fig. 22.

Fusus pleurotomarius Couthouy, 1838, p. 107, pl. 1, fig. 9.

Defrancia vahlii Möller (ex Beck MS.), 1842b, p. 86.

Pleurotoma pyramidalis Mörch, 1869, p. 22.

Pleurotoma pyramidalis var. *jenisseensis* Leche, 1878, p. 56, pl. 1, figs. 17a-b.

Bela pyramidalis G. Sars, 1878, p. 222, pl. 16, fig. 3 (typical form).

Bela pyramidalis var. *semiplicata* G. Sars, 1878, p. 222, pl. 16, fig. 4.

Three specimens were collected: 1 recently vacated shell (19.8 by 7.4 mm.), with part of the nucleus missing, was taken at 295 feet; 1 living (17.7 by 7 mm.) at 453 feet; and a broken shell at 477 feet. These shells are white. (See pl. 16, figs. 10, 11.)

In addition to the above, 3 specimens of what are probably "*O.*" *pyramidalis* var. *semiplicata* G. O. Sars were taken: 2 living specimens (12.8 by 5.8 mm. and 14 by 6.1 mm.) from 152 feet; and 1 drilled shell (15.4 by 6.9 mm.) from 216 feet. The dead shell is white, the living ones are an olive tan. (See pl. 16, figs. 12, 13.) A specimen 11.7 mm. high from 217 feet was identified by Dr. Thorson as *Bela pyramidalis* var. *vahlii* (pl. 17, figs. 6, 7).

DISCUSSION: Dr. Thorson wrote me that the specimens of "*O.*" *pyramidalis* from Point Barrow are somewhat larger, but otherwise fully agree with the type and with specimens from Iceland and western Greenland. Mörch (1869) gave the name var. *gigantea* to the largest specimens. Dr. Thorson also stated that the specimens of var. *semiplicata* have the same structure and sculpture on the uppermost whorls as a specimen in the collection from the Murman Coast, but that the Point Barrow specimens are larger and the last whorl is more tumid. Some of the specimens appear to be identical with Leche's (1878) figure of var. *jenisseensis*.

DISTRIBUTION: Point Barrow to Friday Harbor, Wash. (see Burch, 1946, No. 62, p. 21, for collecting data from the Aleutians to Friday Harbor); and (Thorson, 1944) Grinnell Land to Labrador; western and eastern Greenland; all Iceland, Jan Mayen, Spitzbergen, and northern and southern Norway. The specimens from Point Barrow extend the range into the Pacific area of the Arctic.

Genus *Nodotoma* Bartsch, 1941***Nodotoma impressa* (Mörch, 1869, ex Beck MS.)**

PLATE 16, FIGURES 14, 15

Pleurotoma impressa Mörch, 1869, p. 21.—Leche, 1878, p. 54, pl. 1, fig. 16.

Bela impressa Friele, 1886, vol. 3, p. 18, pl. 8, figs. 1, 2; pl. 10, fig. 9.

Nodotoma impressa Bartsch, 1941, p. 5, pl. 1, fig. 2.

Three specimens were collected: 1 drilled shell (10.2 by 4.9 mm.) from 216 feet; 1 living (8.2 by 4.2 mm.) from 295 feet (pl. 16, fig. 14); and 1 living (9.9 by 4.8 mm.) from 477 feet (pl. 16, fig. 15). The nucleus of the latter was worn but entire and some of the ribs were partly eroded. The nucleus of the one from 295 feet was rather badly worn and the ribs of the first two postnuclear whorls were also badly eroded.

OTHER MATERIAL EXAMINED: Several specimens in the collection of the U. S. National Museum.

DISTRIBUTION: Point Barrow and the Sea Horse Islands to Kodiak Island; and Spitzbergen. Point Barrow is a new locality.

Genus *Raphitoma* Bellardi, 1848***Raphitoma amoena* ? G. O. Sars, 1878**

PLATE 8, FIGURE 8

? *Raphitoma amoena* G. Sars, 1878, p. 220, pl. 17, figs. 10a-b.—Thorson, 1935a, p. 48, figs. 48-49.

Six specimens were dredged: 1 (about 3 mm. long) at 184 feet; 3 (about 2.2, 2.3, and 2.7 mm.) at 216 feet; 1 (about 2 mm.) at 453 feet; and 1 (about 2.5 mm.) at 741 feet.

Discussion: The largest of these shells have 3 whorls and perhaps a fraction of another whorl, including the nucleus. They have very prominent, sharp, spiral folds (pl. 8, fig. 8) that are confined to the periostracum—2 folds on the last whorl and 1 on the next to the last. As in some of the other small shells, the calcified portions have dissolved.

Dr. Thorson, who examined some of these shells, believes that they are either young bottom stages of *Raphitoma amoena* or of some other species of *Raphitoma*. I do not have enough comparative material to continue the study of this species.

DISTRIBUTION: Point Barrow ?; and (Thorson, 1944) eastern and western Greenland, Jan Mayen, Spitzbergen, and Norway north of Lofoten.

Subclass EUTHYNEURA
Order OPISTHOBRANCHIA
Suborder TECTIBRANCHIATA
Family ACTEOCINIDAE
Genus *Retusa* Brown, 1827

Retusa umbilicata (Montagu, 1803)

PLATE 4, FIGURE 6

Bulla umbilicata Montagu, 1803, ed. 1, vol. 1, p. 222.

Cylichna nitidula Lovén, 1846, p. 142.

Cylichna strigella Lovén, 1846, p. 142.—Tryon and Pilsbry, 1893, vol. 15, p. 210, pl. 27, figs. 7, 8; pl. 29, figs. 11–14.

Utriculus nitidulus G. Sars, 1878, p. 286, pl. 17, fig. 13; pl. 26, fig. 3.

Utriculus umbilicatus G. Sars, 1878, p. 286, pl. 17, fig. 14.

Retusa umbilicata Lemche, 1948, pt. 1, p. 81, fig. 45; pt. 2, p. 81, figs. 59–61.

A single dead shell of this species was taken on Sept. 6, 1949, at a depth of 477 feet. The shell is 2.8 mm. in height by 1.5 mm. in width.

OTHER MATERIAL EXAMINED: Approximately 200 specimens from the Shetlands, Scotland, Ireland, Sweden, Norway, the Bay of Biscay (1 specimen) and the Gulf of Naples (1).

DISCUSSION: Lemche (1948) discusses and figures many of the variations found in this species. Among the specimens I examined there were some with a large umbilicus, others with a small umbilicus, and still others with no umbilical perforation; in some there were distinct axial striae and in others such striae were lacking; in some the apical perforation was distinctly visible, in others it was feeble, and in still others it was lacking. One finds all possible combinations of these various characters; for example, one shell may have striae and an umbilicus, another may have striae and no umbilicus and yet another may have neither.

In the specimen from Point Barrow (pl. 4, fig. 6) the apical perforation could be considered lacking or very feeble, the umbilical perforation is lacking, and longitudinal striation may be said to be lacking, for even under high magnification there is such a faint indication of it that one could scarcely term it striation. It is similar to figure 13 of G. Sars (1878) and figure 11 of Tryon and Pilsbry (1893). In the majority of other specimens that I examined the axial striation was lacking.

DISTRIBUTION: Point Barrow, Alaska; the east coast of North America; Norway and Sweden, the British Isles, the Shetlands, the Bay of Biscay, and the Gulf of Naples.

Family DIAPHANIDAE

Genus *Diaphana* Brown, 1827*Diaphana minuta* Brown, 1846Var. *hiemalis* Couthouy

- Diaphana minuta* Brown, 1827, p. 11, pl. 38, fig. 7.—Lemche, 1948, pt. 1, figs. 31–35; pt. 2, p. 72, figs. 1–21.—Abbott, 1954, p. 277, fig. 59b.
- Diaphana candida* Brown, 1827, pl. 38, figs. 13, 14; 1844, p. 59.
- Bulla hyalina* Turton, 1834, p. 353.
- Bulla hiemalis* Couthouy, 1839, p. 180, pl. 4, fig. 5.
- Bulla debilis* Gould, 1840, p. 196; 1841, p. 164, fig. 95.
- Bulla subangulata* Möller, 1842b, p. 79.
- Utriculus candidus* Brown, 1844, p. 59, pl. 19, figs. 13, 14.
- Amphisphyra globosa* Lovén, 1846, p. 143.
- Amphisphyra expansa* Jeffreys, 1865a, p. 330.
- Diaphana hyalina* G. Sars, 1878, p. 289, pl. 18, figs. 1a–b.
- Diaphana expansa* G. Sars, 1878, p. 289, pl. 18, figs. 2a–b.
- Diaphana globosa* G. Sars, 1878, p. 290, pl. 18, figs. 3c, 4.
- Diaphana hiemalis* G. Sars, 1878, p. 291, pl. 18, figs. 3a–c.
- Diaphana glacialis* Odhner, 1907, vol. 41, pp. 53, 97, pl. 1, figs. 1–5.
- Diaphana spirata* Odhner, 1907, vol. 41, pp. 53, 97.

Two living specimens were dredged, the larger (3.5 mm. high by 2.8 mm. in diameter) from 741 feet, the smaller (about 2.9 by 2.2 mm.) from 295 feet.

OTHER MATERIAL EXAMINED: The figured type of *B. hyalina* and several others from the Shetlands, the British Isles, Norway, and Greenland. The figured type of "*Utriculus*" *expansus* (Jeffreys) and 13 others from the Shetlands, Spitzbergen, Norway, and Greenland. The figured type of *A. globosa* and 15 others from the Shetlands, Norway, and Greenland. And others.

DISCUSSION: Lemche (1948), who has made a thorough morphological study of the northern species of *Diaphana*, finds no difference in the soft parts and radulas of the species names listed in the synonymy above. However, he recognizes 3 varieties of shells in the variable species of *D. minuta*, but finds intergradations between all of these varieties. In typical *D. minuta* var. *minuta* the spire is visible and the aperture is shorter than the shell. In the var. *hiemalis* Couthouy (plus *globosa* Lovén) the spire is hidden, and the aperture extends the full length of the shell. In the var. *spirata* Odhner (1907, p. 97) there is a prominent "first whorl" or larval shell, which may protrude even if the rest of the spire is more or less sunken.

With the exception that the larger one is entirely milky white and the smaller one partially milky white, rather than hyaline, the shells from Point Barrow conform to the description of *D. globosa* and therefore belong to the var. *hiemalis* Couthouy. (A chalky appearance has been noted in several Arctic shells that are supposed

to be hyaline or pearly.) In these 2 specimens the spire is very much sunken and is visible only from an end view; the aperture extends the entire length of the shell and the outer lip extends beyond the vertex.

After examining many shells in the *D. minuta-hiemalis-globosa-debilis-hyalina* complex, it becomes obvious that they all belong to the same species, for there are all types of intergrades. For example, in 3 specimens from Spitzbergen (labeled *U. subangulatus*) there is one in which the apex extends beyond the aperture, one in which only the tip of the apex is visible from the side, and one in which the apex is invisible from the side.

DISTRIBUTION: *D. minuta* is a new name for the Pacific area of the Arctic, but under the name of *D. globosa* it has been recorded from Bering Strait northward. Point Barrow is a new locality. Lemche (1948) lists *D. minuta* from Maine to Massachusetts and the Gulf of St. Lawrence; from Jan Mayen, Spitzbergen, the Murman Coast, the Faroes, the Shetlands, Iceland, northern and southern Norway, western Europe, the Canary Islands, and the Mediterranean.

Family SCAPHANDRIDAE

Genus *Cylichna* Lovén, 1846

Cylichna occulta (Mighels, 1841)

PLATE 4, FIGURE 3

Bulla striata (not Bruguière nor Hutton) Brown, 1827, pl. 38, fig. 41; 1844, p. 57, pl. 19, figs. 41, 42.

Bulla occulta Mighels, 1841, p. 50.—Mighels and Adams, 1842, p. 54, pl. 4, fig. 11.

Bulla reinhardti Möller, 1842b (ex Holbøll, MS.), p. 79.

Bulla scalpta Reeve, 1855, p. 392, pl. 32, figs. 3a-c.

Cylichna propinqua M. Sars, 1859, p. 49.—G. Sars, 1878, p. 284, pl. 18, fig. 5; pl. XI, fig. 5.

Cylichna solitaria Friele (not *C. solitaria* Say), 1878, p. 225.

Cylichna occulta Lemche, 1948, p. 78, figs. 31-40.

One specimen (6 mm. high by 3.5 mm. in diameter) was taken through the ice on Jan. 25, 1950, at a depth of 33 feet; and one (4 by 2.4 mm.) was taken near shore on July 13, 1950. Both were taken with a plankton net when it touched bottom. The flesh of these animals was white and the shell is cream colored.

OTHER MATERIAL EXAMINED: About 55 specimens (including dead shells) from localities ranging from Point Barrow to Kyska Harbor in the Aleutians; about 35 specimens from Novaya Zemlya, Spitzbergen, Norway, Scotland, and Greenland. These were labeled *C. reinhardti*, *C. striata*, *C. umbilicata*, *C. propinqua*, and *C. scalpta*.

DISCUSSION: In his study of the northern species of this genus, Lemche (1948) found that the species listed in the synonymy above all belong to the species *C. occulta*, in which he recognized two varieties: *occulta* and *scalpta*, the latter being broader than var. *occulta*. He also described a new species, *C. magna*, specimens of which had been identified under some of the above names. He found that *C. occulta* and its varieties are found in shallow water, and *C. magna* in deeper water.

In the specimens that I examined, the shells of living specimens range from creamy white to brown, and from those with a closed umbilicus (pl. 4, fig. 3) to those with an open umbilicus.

DISTRIBUTION: Point Barrow to the Aleutians; Greenland to Maine; and (Lemche, 1948) Iceland, Spitzbergen, Finmarken, the Murman Coast, the White Sea, and north of Siberia.

Family PYRAMIDELLIDAE

Genus *Odostomia* Fleming, 1813

Odostomia cassandra Dall and Bartsch, 1913

PLATE 8, FIGURES 5, 6

Odostomia cassandra Dall and Bartsch, 1913, p. 142, pl. 10, fig. 2.

Seven specimens were dredged: 1 (2.8 mm. or more long, with 4 whorls) from 140 feet on Aug. 21, 1948; 1 (1.9 mm., with 3.5 whorls) from 216 feet; 2 (1.4 mm., with 3 whorls; and 1.6 mm., with 3 whorls) from 453 feet; and 2 (1.4 mm., with 2.5 whorls; and 2 mm., with 3 whorls) from 741 feet. In addition, there is a specimen from 741 feet in which the shell was completely dissolved by the preservative. The animal is about 3.2 mm. long and 2 mm. in diameter, and a yellow operculum is present.

OTHER MATERIAL EXAMINED: The type from the Queen Charlotte Islands. (Only 1 other specimen, the cotype, has been recorded.)

DISCUSSION: In these shells the aperture is as long as or longer than the remainder of the shell; there is no sculpturing except fine, silky lines of growth. At first these shells were opaque and white, with a silky sheen, but in alcohol they have become hyaline. The type, which is somewhat larger than the largest specimen (with a shell) from Point Barrow, is not highly calcified and appears somewhat hyaline in spots.

DISTRIBUTION: Point Barrow and Skidegate, Queen Charlotte Islands, British Columbia. The Point Barrow specimens extend the range from the 55th to beyond the 71st parallel of latitude.

Suborder PTEROPODA

Family SPIRATELLIDAE

Genus *Spiratella* Blainville, 1817*Spiratella helicina* (Phipps, 1774)

Clio helicina Phipps, 1774, p. 195.

? *Limacina pacifica* Dall, 1871, p. 138.

Limacina helicina G. Sars, 1878, p. 328, pl. 29, figs. 1a-b.—Odhner, 1907, p. 92.

? *Spiratella pacifica* Abbott, 1954, p. 292, fig. 64a.

Only 2 specimens of this pteropod were taken, both in plankton hauls made on Aug. 6 and Aug. 10, 1948.

DISCUSSION: Since no special attempt was made to collect pelagic forms, the few records for this species are of little significance and no indication of its actual abundance. However, the failure to take *S. helicina* during the summers of open water of 1949 and 1950 is consistent with the lesser numbers of ctenophores, medusae, and jellyfishes as compared with the enormous numbers seen near shore during 1948 when floating ice was present throughout the summer. Workers at the Arctic Research Laboratory reported that *S. helicina* was exceedingly abundant during the summer of 1947, and other workers have reported that untold numbers were seen during certain summers between 1950 and 1955 and almost none were seen during other summers.

Lemche (1938, p. 31) lists *S. helicina* as a true Arctic and circumpolar species and states that it does not occur in boreal waters. Abbott (1954, p. 292) considers *S. pacifica* (Dall) synonymous with *S. helicina* (Phipps). Burch (1945, No. 47, p. 5) gives the range of *S. pacifica* as Point Barrow south to Redondo Beach, Calif., where he took it in 75 fathoms 5 miles offshore. The type locality of *S. pacifica* is Monterey, Calif., and it has been taken at San Francisco; it has been reported also from 30 fathoms at Catalina Island. If *S. pacifica* and *S. helicina* are identical, then *S. helicina* is a Boreal-Arctic species.

DISTRIBUTION: Circumpolar; Point Barrow south to Monterey, Redondo Beach, and Catalina Island, California (?); Labrador, Davis Strait, and Baffin Bay; and (Odhner, 1907) northern and southern Norway, the White Sea, Spitzbergen, Iceland, the Gulf of Biscay, and the Mediterranean.

Family CLIONIDAE

Genus *Clione* Pallas, 1774*Clione limacina* (Phipps, 1774)

Clio limacina Phipps, 1774, p. 195.

Clione limacina Gould, 1870, p. 507, fig. 754.—G. Sars, 1878, p. 332, pl. 29, figs. 4a-e.—Odhner, 1907, p. 95.—Pratt, 1935, p. 578, fig. 758 (after Gould).

During the summers of 1949 and 1950 this species was taken sparingly, but during the summer of 1948 it was very abundant, especially on August 12 when it was seen alongshore in enormous numbers, together with etenophores, medusae, and jellyfishes.

DISCUSSION: During the winter of 1949–1950, veliger larval forms of this species were taken in vertical plankton hauls through the ice. Throughout the entire winter they appeared to be in a state of suspended growth, for all of the larvae taken were the same size. However, on June 23, 1950, 4 large adults, about 38 mm. in length, were taken in a screen trap lowered through the ice where the water was 37 feet deep. On July 7, 1950, a larval form 7 mm. in length, that was still propelling itself by means of cilia, and a specimen 30 mm. in length were taken. About this time young *C. limacina* were becoming common alongshore.

DISTRIBUTION: This is a Boreal-Arctic species that has been recorded in Pacific waters from northern Bering Sea south to the Pribilofs and, rarely, in the Aleutians, hence not farther south than lat. 52° N.; in eastern Atlantic waters it has been recorded from the White Sea, Jan Mayen, Spitzbergen, the British Isles, and the Faroes—as far south as lat. 35° N.; and in the western Atlantic (Johnson, 1934) from Davis Strait to lat. 37° N. In view of its abundance at Point Barrow, it is surprising that it has not been recorded previously from north of Bering Sea.

Suborder NUDIBRANCHIA

Division DORIDACEA (=HOLOHEPATICA)

Family DORIDIDAE

Genus *Aldisa* Bergh, 1878*Aldisa zetlandica* (Alder and Hancock, 1855)

Doris zetlandica Alder and Hancock, 1855, pt. 7, and appendix, p. 42.—G. Sars, 1878, p. 305, pl. 27, figs. 1a-b.

Aldisa zetlandica Odhner, 1907, p. 67.—Alder and Hancock, 1910, p. 105, pl. 1, figs. 3, 4.

Six specimens were collected: 1 (32 mm. long by 30 mm. wide, when somewhat contracted) was dredged from a sandy-muddy bottom

at a depth of 10 feet and a distance of 300 feet from shore on July 20, 1948; 2 were dredged from a sandy bottom at a depth of 10 to 15 feet and a distance of 75 to 150 feet from shore on Sept. 8, 1948; and 3 (34 by 22 by 13 mm., 34 by 21 by 13 mm., and 30 by 21 by 12 mm.) were washed ashore on Oct. 16, 1949.

These animals were white, with a cream colored foot; the gonads showed through as buff, the gut as black. The entire dorsum is covered with small papillae from which fine lines radiate. The mantle extends beyond the foot all around. The rhinophores are located unusually far back and the branchiae very far back on the dorsum. The 12, equal-sized branchiae are in a ring with the anal pore in the center; anal papilla short or absent.

DISTRIBUTION: Point Barrow, Alaska; and (Lemche, 1941) northern and eastern Iceland (in deep water), Finmarken, and other European waters; and (Odhner, 1907) Shetland, and the Azores. It is new to North America.

Division AEOLIDIACEA (= CLADOHEPATICA)

Family DENDRONOTIDAE

Genus *Dendronotus* Alder and Hancock, 1845

Dendronotus frondosus (Ascanius, 1774)

PLATE 3, FIGURE 1

Amphitrite frondosa Ascanius, 1774, p. 155, pl. 5, fig. 2.

Doris arborescens Müller, 1776, p. 229, pl. 101, figs. 1-4.

Dendronotus arborescens Alder and Hancock, 1845-1910, vol. 2, p. 161; fam. 3, pl. 3; Suppl., pl. 47, fig. 2.

Dendronotus frondosus G. Sars, 1878, p. 314.—Odhner, 1907, p. 64.—Lemche, 1941, p. 23.

Twenty specimens were collected: 2 were dredged at a depth of 140 feet on Aug. 21, 1948; and 1 at a depth of 150 feet on Aug. 23, 1949; the remaining 17 specimens washed ashore between Sept. 12 and Oct. 5, 1949. The largest specimen (from 140 feet) was 115 mm. long; the next largest (washed ashore on Sept. 12) was 95 mm. long, 25 mm. wide, and 27 mm. high, and the maximum length of the cerata was 21 mm.

These specimens were a rich, reddish brown on a cream background.

DISTRIBUTION: Point Barrow, and Bering Sea; and (Lemche, 1941) the east coast of North America (Labrador to Cape Cod), western and eastern Greenland; northern and eastern Iceland, the Faroes, the Shetlands, Spitzbergen, Franz Josef Land, northern and southern Norway, and other European waters south to France. It is new to the western Arctic.

Dendronotus sp.

Four animals were collected: 2 were dredged at a depth of 150 feet on Aug. 23, 1948; 1 washed ashore on Sept. 26, 1949, and another on Sept. 28, 1949. These specimens measured up to 40 mm. in length. The bodies were translucent white, with chalk white tips on the branches of the cerata.

Family FLABELLINIDAE

Genus *Coryphella* Gray, 1850*Coryphella salmonacea* (Couthouy, 1838)

Eolis salmonacea Couthouy, 1838, p. 68, pl. 1, fig. 2.

Coryphella salmonacea Bergh (not of M. Sars, 1829, nor G. Sars, 1878), 1864, p. 227, pl. 4.—Hägg, 1905, p. 106.—Odhner, 1922, p. 31, fig. 13a.—Lemche 1941, p. 25.

Aeolis papillosa Hägg, 1905, p. 104.

Four specimens were collected: 3 (28, 42, and 42 mm. long) washed ashore on Sept. 26, 1949; and 1 (42 mm. long) washed ashore on Oct. 16, 1949. These animals were pinkish salmon in color.

Two specimens, probably belonging to another species, and possibly to another genus, were dredged: 1 (30 mm. long) at Eluitkak Pass on Aug. 30, 1948; and 1 and a fragment at 110 feet on Sept. 16, 1948. The bodies and tentacles of these 2 animals were white, the cerata brick-red, tipped with white.

DISTRIBUTION: Point Barrow, Alaska, and (Lemche, 1941) Bering Strait; east coast of North America south to Cape Cod, western and eastern Greenland; northern and eastern Iceland, Jan Mayen, Spitzbergen, and the north coast of Norway. It is new to Point Barrow and to Arctic Alaska.

Class AMPHINEURA

Family LEPIDochITONIDAE

Genus *Trachydermon* Carpenter, 1863*Trachydermon albus* (Linnaeus, 1767)

PLATE 17, FIGURES 3, 4

Chiton albus Linnaeus, 1767, ed. 12, p. 1107.

Lepidochitona alba Tryon and Pilsbry, 1879–1898, vol. 14, p. 70, pl. 7, figs. 35–38.

Thirty-nine specimens were taken: 1 (13 mm. long) from 120 feet (Aug. 8, 1949); 1 (14 mm.) from 130 feet (Sept. 15, 1948); 1 (9 mm.) from 130 feet (Aug. 9, 1949); 1 (9.5 mm.) from 184 feet; 7 (from 9 to 15 mm.) from 217 feet; 1 (10 mm.) from 328 feet; 2 (13 mm.) from 341 feet; 7 (from 3 to 13 mm.) from 420 feet; 1 (16 mm.) from

438 feet; 9 (from 7 to 17 mm.) from 453 feet; and 5 (from 6 to 15 mm.) from 522 feet.

OTHER MATERIAL EXAMINED: Over 100 specimens from localities ranging from the Sea Horse Islands through Bering Strait, Plover Bay, the Shumagins, the Aleutians, and Juneau, Alaska.

DISCUSSION: The "*albus*" refers to the white of the inside of the valves. Externally, the valves, as well as the girdle, range between a dusty white or cream color (pl. 17, fig. 4) to a condition in which brown predominates (pl. 17, fig. 3), the dark color being due to microscopic specks of pigment. As in specimens from other localities, the darker colored ones predominate at Point Barrow, but in several specimens from 420 feet the white area is greater than that with brown pigmentation.

A single specimen (USNM 214438) from San Francisco Bay labeled *T. albus* does not belong to this species. The "spicules" of the girdle are too fine for *T. albus*, there is a nodule on the posterior valve that is not present in *T. albus*, and the apex of the valves is drawn into a more prominent point than in *T. albus*. The lateral areas are ill defined. A small specimen (USNM 218739) from Monterey Bay is also incorrectly named *T. albus*—the plates are narrower, the sculpture is coarser and in definite rows rather than in an over-all effect as in *T. albus*, and, as in the specimen from San Francisco, it also has the nodule on the posterior valve. In still another specimen (USNM 159351), from San Diego, the "spicules" of the girdle are fine, giving an impression of piling, the sculpture is coarser than in *T. albus*, and the nodule is present. Time did not permit the identification of these 3 specimens, which may represent a new species.

However, 9 specimens (USNM 224045) from the Stearns Collection, labeled "West Coast of Lower California," are *T. albus*.

DISTRIBUTION: Point Barrow south and east to Juneau, Alaska, and, if the above locality record is correct, the west coast of Lower California; the Gulf of St. Lawrence south to Massachusetts Bay; the British Isles; Spitzbergen; Norway.

Family CRYPTOCHITONIDAE

Genus *Symmetrogephyrus* Middendorff, 1847*Symmetrogephyrus vestitus* (Broderip and Sowerby, 1829)

PLATE 17, FIGURES 1, 2

Chiton vestitus Broderip and Sowerby, 1829, p. 368.—Sowerby, 1841, pl. 171,

Chiton, fig. 128.

Amicula vestita J. Gray, 1847b, p. 69.—Oldroyd, 1927, pt. 3, p. 322.

Symmetrogephyrus vestitus Dall, 1921, p. 198.—Abbott, 1954, p. 316, fig. 66c.

Forty-two specimens were dredged: 1 at 138 feet, 1 at 152 feet, 3 at 217 feet, 1 at 295 feet, 2 at 328 feet, 10 at 341 feet, 4 at 420 feet, 5 at 438 feet, 12 at 453 feet, 2 at 522 feet, and 1 (11 mm. long) at 741 feet. They range in length from 11 to 62 mm.

On the epidermis of one chiton from 453 feet an amphipod was curled up in a depression formed to fit it. Young barnacles may be attached to the tips of the valves and foraminifers are often nestled in the depressions formed at the junction of the plates and epidermis. Around one plate there were 11 foraminifers of varying sizes. Foraminifers may also nestle in the epidermis and form depressions to fit, as they do on tunicates. On the chiton from 295 feet, over 15 foraminifers were thus embedded, some so deeply that, with their covering of detritus, they were difficult to see. Also on this chiton, growing attached to or near the base of some of the tufts, were small colonies of the bryozoan *Coriella stolonata*.

OTHER MATERIAL EXAMINED: Over 20 specimens from localities ranging from off Cape Sabine in the Arctic to Kyska Harbor in the Aleutians; 6 specimens from Nova Scotia, Maine, and Massachusetts Bay.

DISCUSSION: In this chiton only the apex of the valve is visible, the remainder being covered by the expanded girdle, which is dotted with irregularly spaced tufts of stiff bristles. Relatively more of the surface of the valves is visible in smaller than in larger specimens. The girdle is cream colored, the bristles brownish.

The most noticeable variation is in the number of tufts of bristles. In some specimens the tufts are very sparse, in others unusually thick. Some of the specimens from Point Barrow are fairly thickly tufted (pl. 17, fig. 1), others have very few tufts (pl. 17, fig. 2). In 4 specimens from Bering Island the tufts average only about 1 mm. apart. The size of the tufts varies in any individual specimen as well as in different individuals. The spicules on the epidermis may be sparse or thick.

DISTRIBUTION: Point Barrow south to the Pribilofs, Kyska Harbor in the Aleutians, Hagemeister Island in Bristol Bay. Dall (1921) gives the Atlantic range as "south to Cape Cod." It is new to Point Barrow.

Class CEPHALOPODA

Order DECAPODA

Family GONATIDAE

Genus *Gonatus* Gray, 1849*Gonatus fabricii* (Lichtenstein, 1818)

Onychoteuthis fabricii Lichtenstein, 1818a, p. 1592, pl. 19; 1818b, p. 13.

Gonatus amoenus G. Sars, 1878, p. 336, pl. 31, figs. 1-15.—Verrill, 1881, p. 291, pl. 45, figs. 1, 2.

Gonatus fabricii Steenstrup, 1881, p. 25, pl. 1.—Hoyle, 1886, pp. 41, 174.—Berry, 1912, p. 308, pl. 52, figs. 1-4; pl. 53; pl. 54, figs. 1-4; pl. 45.—G. E. MacGinitie, 1955, p. 180.

Three specimens, with bodies measuring 59, 63, and 72 mm. in length, were washed ashore on Oct. 1, 1949. (For more detailed measurements, see G. E. MacGinitie, 1955.) The animals were cream colored, spotted with red. (These animals were identified by Dr. Gilbert L. Voss of the University of Miami Marine Laboratory.)

DISTRIBUTION: Point Barrow, Alaska and (Berry, 1912) Bering Island (east of Kamchatka, approximately latitude 55° N. and longitude 166° W.), British Columbia?, Washington?, Monterey, and off San Nicolas Island, Calif., and off Los Coronados Islands, Lower California; Kuril Island, Japan, Punta Arenas, Patagonia; Davis Strait off Greenland, Iceland, the Faroes, Jan Mayen, Norway, Finmark, Ireland, France, and south of Cape of Good Hope; Nova Scotia and Rhode Island. It is new to Point Barrow and Arctic Alaska.

Order OCTOPODA

Family CIRROTEUTHIDAE

Genus *Cirroteuthis* Porro, 1841*Cirroteuthis* sp.

Cirroteuthis sp. G. E. MacGinitie, 1955, p. 179.

Two specimens were taken with a dip net in about 6 feet of water at the outer edge of an ice floe that had stranded along shore. The smaller specimen was a juvenile; the larger had an over-all length of 25.7 cm. (More detailed measurements are given in the above reference.) The dominating color was pale maroon.

Dr. Grace E. Pickford (who identified this and the following species) was unable to place this *Cirroteuthis* specifically because she saw only the juvenile, the larger specimen having been lost in transit.)

DISCUSSION: Dr. Pickford states that this species differs in several respects from a well-known North Atlantic species, and that the only

other record of the genus from the Pacific area is that of a single specimen of *C. hoylei* Robson taken off Valparaiso, Chile, by the *Challenger*.

The appearance of this deeper-water animal along shore is accounted for by upwelling water following an offshore wind of three days duration.

Family OCTOPODIDAE

Genus *Benthoctopus* Grimpe, 1921

Benthoctopus hokkaidensis (Berry, 1921)

Polypus glaber Sasaki, 1920, pp. 163, 167, 172 (not *P. glaber* "Ruppell" Wülker).
Polypus hokkaidensis Berry, 1921, p. 352 (new name for *P. glaber* Sasaki, not Wülker).

Octopus hokkaidensis Sasaki, 1929, pp. ii, 33, 63, 66; text figs. 24-26; pl. 4, figs. 4, 5; pl. 11, fig. 5.¹²

One specimen, a gravid female, was taken at a depth of 216 feet on Oct. 6, 1949. The body, marked with light orange on a cream background, was 85 mm. long and 57 mm. in diameter, with arms 150 mm. long.

DISTRIBUTION: Originally taken off Japan by the *Albatross* and more recently by the Russians in Bering Sea and the Sea of Okhotsk. It is new to the Arctic.

Class PELECYPODA

Order PRIONODESMACEA

Suborder TAXODONTA

Family NUCULIDAE

Genus *Nucula* Lamarck, 1799

Nucula tenuis (Montagu, 1808)

Var. *expansa* Reeve

PLATE 18, FIGURE 4

Arca tenuis Montagu, 1808, suppl., p. 56, pl. 29, fig. 1.

Nucula expansa Reeve, 1855, appendix, p. 397, pl. 33, fig. 2.

Nucula tenuis and var. *expansa* Soot-Ryen, 1932, p. 4, pl. 1, figs. 3, 4, 6.

Nucula tenuis Morris, 1951, p. 6, pl. 7, fig. 6.

Of the 96 specimens collected from 19 stations, over half came from depths of less than 125 feet. The highest yields were 17 from 118 feet, 14 from 120 feet (Aug. 8, 1949), 14 from 122 feet, 7 from 151 feet,

¹²For this synonymy I am indebted to Dr. S. Stillman Berry.

and 6 from 72 feet. Single specimens were taken at 246, 341, and 741 feet, and 2 specimens at 477 feet. (The last 2 stations were characterized by muddy bottom, as were the ones at less than 125 feet.) By means of dogteam dredging during the winter of 1950, 6 specimens were taken at 149 feet and 7 at 162 feet, where they had been "transplanted" by the storms of autumn. Six other stations yielded from 2 to 4 specimens each.

The majority of the specimens were over 10 mm. in length, the longest measuring 15.5 mm., the smallest about 6.7 mm.

OTHER MATERIAL EXAMINED: Numerous specimens from the Alaskan Arctic, Siberia, the Aleutians, southern California, and Japan; Massachusetts, Greenland, the British Isles, Norway, and Spitzbergen.

DISCUSSION: In the Point Barrow specimens there is marked variation in the degree of obesity and some variation in the proportion of length to height. None of the specimens is exceedingly thin, but they undoubtedly all belong to the typical form and the var. *expansa* Reeve, with transitional forms.

In the specimens from Point Barrow the yearly growth lines (pl. 18, fig. 4) are often prominent and individuals from 11 to 14 mm. in length appear to be about 3.5, possibly 4.0, years old.

DISTRIBUTION: *Nucula tenuis* is known from the western Arctic south to southern California, from the eastern Arctic south to North Carolina, and from north of Europe south to the Mediterranean.

Family NUCULANIDAE

Genus *Nuculana* Link, 1807

Nuculana minuta (Fabricius, 1776)

PLATE 18, FIGURE 3

Arca minuta Fabricius, 1776, p. 414.

Leda minuta G. Sars, 1878, p. 36, pl. 5, figs. 2a-b.—Oldroyd, 1924, p. 15, pl. 19, figs. 2, 2a.

Nuculana minuta Morris, 1952, p. 8, pl. 1, fig. 12.

Thirty-one living specimens were taken from 17 stations ranging in depth from 70 to 741 feet. Five specimens came from 741 feet, 4 from 477 feet, and 3 each from 295, 341, and 420 feet. The smallest specimen (from 741 feet) is 6.5 mm. in length; the largest (from 522 feet) is 16.5 mm. in length by 8.5 mm. in height by 5.7 mm. in breadth; the next largest (from 175 feet) is 15.6 by 8.4 by 5.3 mm.

OTHER MATERIAL EXAMINED: Several specimens in the collection of the U. S. National Museum.

DISCUSSION: I am indebted to W. K. Ockelmann of Copenhagen for identifying this species. The specimens from Point Barrow are less inflated and have a relatively longer rostrum than the specimens of

N. minuta that I examined; however, these differences come well within the normal limits of variation in this species.

DISTRIBUTION: Point Barrow, Alaska, south to San Diego, Calif., also to Japan. Madsen (1949) gives the Atlantic range as northeast America south to the Bay of Fundy; Greenland, Iceland, Spitzbergen, and along Norway and south to the English Channel.

Nuculana radiata (Krause, 1885)

PLATE 18, FIGURE 2

Leda pernula var. *radiata* Krause, 1885a, p. 23, pl. 3, figs. 2a-c.

Leda radiata Dall, 1921, p. 11.

A single live specimen, measuring 23.2 by 12.8 by 7 mm., was dredged at a depth of 80 feet on Aug. 21, 1948.

OTHER MATERIAL EXAMINED: None.

DISCUSSION: Although this specimen appeared to agree with the description and figures by Krause, I am indebted to W. K. Ockelmann for confirming the identification.

This species has high and prominent umbos, fewer hinge teeth than the smaller *N. minuta*, and a periostracum characterized by fine, dark, often broken, radiating ridges that cross the concentric ribs. Soot-Ryen (1932) states that no other species of *Nuculana* exhibits this curious radiating sculpture.

DISTRIBUTION: Soot-Ryen (1932) gives the range of this species as follows: Arctic Pacific: Chukchi and Beaufort Seas, Bering Strait and Sea, and the Sea of Okhotsk. Point Barrow represents a new locality.

Genus *Yoldia* Möller, 1842

Yoldia arctica (Gray, 1824)

PLATE 18, FIGURE 8

Nucula arctica J. Gray, 1824, p. 214.

Portlandia arctica G. Sars, 1878, p. 37, pl. 4, figs. 7a-b.

Leda arctica Oldroyd, 1924, p. 26, pl. 19, figs. 6, 6a.

Yoldia arctica Gardner, 1916, p. 518.—Morris, 1951, p. 9, pl. 41, fig. 11.

A single specimen, 13.9 mm. long by 8.7 mm. high by 5.6 mm. in breadth, was taken on Aug. 4, 1948, at a depth of 28 feet. The shell has a yellowish green periostracum, and apparently is either 3.5 or 4.5 years old.

OTHER MATERIAL EXAMINED: Over 60 specimens from Spitzbergen, Norway, and Arctic Canada (including about 30 specimens, mostly large, from Wellington Channel); 3 specimens from Collinson Point, Alaska; and about 40 specimens, labeled var. *lutescens*, collected by Captain Belcher from the "Arctic Ocean."

DISCUSSION: Specimens vary in color from olive green to brown to brownish black. There is also great variation in the degree of obesity

and in the degree of truncateness. In the var. *lutescens* the keel appears to be slightly higher near the umbos than in the typical form.

A specimen 16.5 by 10.7 by 6.9 mm. from the "Arctic Ocean" shows 7 distinct growth cessation lines (much darker than the surrounding areas of the shell) with a narrower secondary line between some of these; another, 20.1 by 13.6 by 9.8 mm., shows 9 distinct growth cessation lines with a few secondary lines; still another, only 15.9 mm. long, shows 11 or 12 nearly equally strong lines.

DISTRIBUTION: Collinson Point and Point Barrow, Alaska; Wellington Channel, Canada, south to Greenland; also Spitzbergen and Norway.

Yoldia myalis (Couthouy, 1838)

PLATE 18, FIGURE 1

Nucula myalis Couthouy, 1838, p. 62, pl. 3, fig. 7.

Yoldia myalis Gould, 1870, p. 160, fig. 467.—Oldroyd, 1924, p. 30, pl. 5, fig. 8.—

Abbott, 1954, p. 340, pl. 27d.—Ockelmann, 1954, p. 18, pl. 1, fig. 5; pl. 2, figs. 5, 10.

Approximately 35 specimens were taken from 18 stations at depths ranging from 72 to 453 feet: 12 were taken from 213 feet, 1 from 453 feet, 1 from 295 feet, 1 from 246 feet, and 1 from 204 feet, the remainder coming from depths of less than 200 feet, with from 1 to 3 specimens per station.

OTHER MATERIAL EXAMINED: Over 100 specimens from localities ranging from Cape Smythe, Alaska, to the Aleutians, southeast Alaska, and Puget Sound; also over 25 specimens from Nova Scotia, Maine, and Massachusetts.

DISCUSSION: The fossette varies in depth and in shape, being short and triangular in some specimens and longer and narrower in others. The pallial sinus may be rounded or truncate at the anterior end and it may or may not be long enough to reach to a vertical line extended from the beaks. Some shells are much heavier than others.

DISTRIBUTION: From Point Barrow to Puget Sound; from Hudson Strait to Massachusetts.

Yoldia hyperborea Torrell, 1859 (ex Loven, MS.)

PLATE 18, FIGURE 5

Nucula hyperborea Loven, MS.

Yoldia hyperborea Torrell, 1859, p. 149, pl. 2, figs. 6a-b.—Odhner, 1910, p. 18, pl. 1, fig. 23.—Ockelmann, 1954, p. 8, pl. 1, figs. 1, 2; pl. 2, figs. 1-4.

About 14 living specimens and several valves were collected, the living ones as follows: 1 at 10 feet (Sept. 8, 1949), 1 at 70 feet, 1 at 72 feet, 1 at 80 to 100 feet (Aug. 21, 1948), 1 at 120 feet (Sept. 8, 1949),

5 at 132 feet, 1 at 134 feet, 2 at 141 feet, and 1 at 477 feet. The majority range between 25 and 35 mm. in length; the largest is 39.4 mm., the smallest is 13.9 mm.

OTHER MATERIAL EXAMINED: One specimen from the Barents Sea, 13 from Spitzbergen, 7 from Norway, 1 from Iceland, 2 from Disco Bay, Greenland; 1 from Wellington Channel, Northwest Territories, Canada (about lat. 76° N.), 5 from off Beachy Island, Labrador, and 5 from 60 fathoms, Labrador, and 1 from Massachusetts Bay; approximately 50 from 18 stations from Kotzebue Sound to Plover Bay, to Norton Sound, to Kamchatka, St. Matthew Island, Nunivak Island and the Pribilofs; and 13 specimens (Stanford Collection) from deep water off Humboldt Bay, Calif.

DISCUSSION: *Yoldia hyperborea* has not appeared in our Western literature because it has been identified with *Y. limatula* (see Morris, 1947, pl. 1, fig. 5; 1952, pl. 1, fig. 8), some authors considering the former merely an obtuse form of *Y. limatula* (Madsen, 1949, p. 20). One of the difficulties appears to be the great variation in the proportions of *Y. hyperborea*. Typical adult *Y. hyperborea* are about twice as long as high or even slightly less than twice as long as high, but other specimens may be more than twice as long as high. These latter specimens also have a more pointed posterior end than typical *Y. hyperborea*, leading to confusion with *Y. limatula* and sometimes with *Y. sapotilla* (see Abbott, 1954, pl. 27b).

Ockelmann (1954) has made an analytical study of these 3 species (and of *Y. myalis*) and as a result he erected a new subspecies of *Y. hyperborea*, which he named *limatuloides* (Ockelmann, 1954, pl. 1, fig. 2; pl. 2, fig. 2), characterized by the more pointed posterior end and the length being more than twice the height. He also listed distinguishing characteristics of the four species and the subspecies. Neither *Y. limatula* nor *Y. sapotilla* (see Ockelmann, 1954, pls. 1, 2) have a distinct sinuation in the anteroventral margin of the shell, whereas both *Y. hyperborea* and *Y. h. limatuloides* do have. In both *Y. limatula* and *Y. sapotilla* the umbo is slightly in front of the middle, but in *Y. hyperborea* and *Y. h. limatuloides* the umbo is somewhat behind the middle. In contrast to *Y. myalis*, all of these have a periostracum that appears varnished.

In most of the specimens from Point Barrow, the length slightly exceeds twice the height, but the excess is not so great as in *Y. h. limatuloides*, nor is the posterior end sufficiently pointed for this subspecies.

In color the Point Barrow specimens vary from an olive straw (those under 30 mm. in length) to a dark olive. The umbos and the areas surrounding them are usually lighter colored than the remainder

of the shell; this is especially marked in the larger, darker specimens (pl. 18, fig. 5).

The specimens I examined from north of the Pribilofs appear to be *Y. hyperborea* and, with the exception of the 13 specimens of this species from deep water off Humboldt Bay, those from south of the Pribilofs appear to be *Y. limatula*. Unfortunately, my examination and notes were made before Ockelmann's study was published, so that I cannot give separate ranges for typical *Y. hyperborea* and the subspecies *limatuloides*. However, I did examine typical *Y. hyperborea*: 11 from Spitzbergen, 1 from the Barents Sea, 10 from Labrador, 2 from 175 fathoms from Disco Bay, Greenland. Since the height was less marked than in typical *Y. hyperborea*, the specimens I examined from Norway, Iceland, and Massachusetts Bay may very well be the subspecies *limatuloides* or transitional stages between it and *Y. hyperborea*.

A specimen 40 mm. long from Spitzbergen has 8 or 9 growth cessation lines and several secondary lines, one 31 mm. long has 6 or 7 lines, and one 29 mm. long has 8 lines; one 32 mm. long from Bergen, Norway, has 6 or 7; and one 21 mm. long from the Wellington Channel has 6 or 8 lines.

DISTRIBUTION: Point Barrow south to the Pribilofs, and off Humboldt Bay; Wellington Channel, Jones Sound, Smith Sound, Labrador, and Massachusetts Bay; the eastern Siberian Ice Sea, the Kara Sea, Novaya Zemlya, the White Sea, the Murman Coast, the Barents Sea, Spitzbergen, Norway, Iceland, and Greenland.

Yoldia scissurata Dall, 1898

Yoldia scissurata Dall, 1898, p. 595.

One shell 31 mm. long by 17 mm. high was taken at 141 feet, and a left valve 23.5 mm. long by 12.5 mm. high was washed ashore on Aug. 21, 1949.

OTHER MATERIAL EXAMINED: Seven specimens from northern Japan and over 75 from localities ranging from Point Barrow south through Bering Sea and the Sea of Okhotsk to Bristol Bay, the Aleutians, Sitka Harbor, and the coast of Washington.

DISCUSSION: Grant and Gale (1931, p. 131) suggest that *Y. scissurata* Dall and *Y. ensifera* Dall are synonymous. I find the following differences between the two species: *Y. scissurata* is higher anteriorly and is proportionately longer from the umbos to the anterior end and proportionately shorter from the umbos to the posterior end than *Y. ensifera*. The posterior dorsal blades of the valves are longer and much higher in *Y. ensifera* than in *Y. scissurata*, so that a line from the beaks to the end of the rostrum always cuts across the blades in *Y. ensifera* but seldom does in *Y. scissurata*. The rostrum is more

upturned in *Y. scissurata*. Even in specimens only 5 to 10 mm. long, these differences are apparent and consistent.

A specimen 30 mm. long from the Sea Horse Islands has 7 or 8 growth cessation lines, one 23 mm. long has 6 or 7 lines; one 30 mm. long from the Shumagins has 6 or 8 lines, and one 25 mm. long has 5 or 6 such lines.

DISTRIBUTION: Point Barrow to Monterey Bay; and in the Pleistocene at San Pedro, Calif.

Suborder ISODONTA

Family PECTINIDAE

Genus *Chlamys* Röding, 1798

Chlamys islandica (Müller, 1776)

Pecten islandicus Müller, 1776, p. 248.—G. Sars, 1878, p. 16, pl. 2, fig. 2.—Oldroyd, 1924, p. 54, pl. 8, figs. 1, 2.—Morris, 1947, p. 18, pl. 11, fig. 7; 1951, p. 26, pl. 11, fig. 7.

Chlamys islandica Morris, 1952, p. 17, pl. 4, fig. 4.

This species was taken only sparingly. Because of marked variations in measurements, the specimens are listed in detail in table 4.

OTHER MATERIAL EXAMINED: Several entire shells and about 30 valves from localities ranging from Point Barrow through Bering Sea to the Aleutians and the Shumagins; about 15 shells and as many valves from Greenland, Labrador, Newfoundland, Nova Scotia, Maine; 2 from Vadsø, Norway, and 1 from Finmark, Norway.

DISCUSSION: These shells vary from light to heavy, and the sculpture varies from closely set, fine, rounded or inverted V-shaped, radiating ribs covered with closely set scales to broad, smoother, more widely spaced ribs, usually with a single secondary rib in the wide groove between the primary ribs (pl. 19, fig. 4). The primary ribs of the heavy shells characteristically divide, the resulting two ribs then continuing close together like a double rib. In some of the more highly sculptured specimens with prominent scales, three or more ribs may lie closely together, forming a ridge, with from one to three secondary ribs in the grooves between the ridges. One specimen from Vadsø resembles one from off Cape Cod and one from off Nova Scotia in that the ribs are scaly and tend to group into ridges. Except that the ribs are more closely set and scaler, another specimen from Vadsø resembles the Point Barrow specimens in having broad primary ribs that divide and in having a fine secondary rib between the primary ribs. Not all of the ribs in any one shell necessarily divide. A specimen from Massachusetts Bay resembles the Point Barrow ones more than specimens examined from Iceland.

TABLE 4.—Measurements, in millimeters, of *Chlamys islandica* (Müller) collected at Point Barrow, Alaska

(Key: L, living; Sh, empty shell)

Date	Depth (in feet)	Length	Height	Breadth	Length of Hinge Line	Remarks
9-15-48	110	52.0	62.0	25.0	27.3	L
		72.0	76.0	29.8	33.9	Sh
9-15-48	120	7.8	9.2	2.3	5.3	L ¹
		66.0	69.0	28.5	35.0	L ²
9- 9-48	125	71.5	74.0	31.0	33.5	L ³
10-14-49	175	2.2	2.3	0.8	1.8	L
		11.0	13.0	3.5	7.4	Sh
		11.2	13.0	3.5	7.4	L
8-30-49	184	58.0	61.5	27.5	29.0	Sh
		61.0	67.5	24.3	31.0	Sh
10- 6-49	216	1.3	1.4	?	1.2	L
		2.1	2.0	1.7	1.6	L
		2.4	2.5	1.8	1.8	L
10-11-49	341	71.0	80.0	31.5	34.0	L
8- 9-49	420	71.0	76.0	29.5	35.0	Sh ⁴
		62.0	65.0	25.0	30.0	L
		62.0	68.0	25.0	30.0	L ⁵
8-17-49	438	74.0	78.0	30.0	35.0	L ⁶
8-17-49	522	72.0	76.5	30.7	39.5	L

¹ Among foliaceous bryozoans, and obviously grew in cramped quarters as the ventral edges were incurved so that the height was shortened, although there was little or no erosion.

² Among foliaceous bryozoans, and obviously grew in cramped quarters as the ventral margin was eroded and the ventral edges were incurved so that the height was shortened.

³ This specimen has barnacles of four size groups growing on it (1 large, 6 medium, 6 or 7 small, and numerous tiny individuals), also several tunicates, an encrusting bryozoan, a species of *Earentsia*, colonies of hydroids, and several *Hiattella arctica* nestling around the barnacles.

⁴ Compare with one from 125 feet.

⁵ Convex at ventral margin.

⁶ Compare with one from 522 feet.

The inside of the valves of the Point Barrow specimens tends to be white with sometimes some reddish purple color in the central portion showing through from the outside of the left valve, and occasionally with some of the same color around the edges. Shells examined from Bergen are largely apricot colored on the inside of the left valve and apricot and white on the inside of the right valve; a shell from Vadsø is apricot and purplish inside, and one from Finnmark is apricot with a purplish muscle scar.

DISTRIBUTION: Jensen (1912) gives the range of this species as Labrador, western Greenland, Iceland, Spitzbergen, Barents Sea, entrance to Kara Sea (1 small specimen) but not within the Kara Sea (despite many dredgings), not in the Siberian Polar Sea nor Polar Sea north of Arctic America nor in the High-Arctic of eastern Greenland but in the Bering Sea and one specimen from the coast of Korea and one from the waters south of Vladivostok. In the Atlantic south to Cape Cod and western Norway.

The Point Barrow specimens extend the range into Arctic Alaska and those mentioned above extend it into the Aleutians and the Shumagins.

Suborder DYSODONTA

Family MYTILIDAE

Genus *Mytilus* Linnaeus, 1758*Mytilus edulis* Linnaeus, 1758

Mytilus edulis Linnaeus, 1758, ed. 10, p. 705.—Oldroyd, 1924, p. 66, pl. 27, fig. 4.

On Aug. 10, 1948, one right valve 60.6 mm. long and 31.7 mm. high was dredged at Eluitkak Pass, and on Oct. 1, 1949, a portion of a left valve was found on shore.

OTHER MATERIAL EXAMINED: Numerous specimens from the western Atlantic and the eastern Pacific.

DISCUSSION: The area under investigation was relatively small and in no place was there a suitable habitat for such tidal-zone animals as *M. edulis*. These shell fragments may have been transported by floebergs or by currents.

DISTRIBUTION: World-wide in temperate waters; in the Pacific area from the Arctic (lat. 74° N.) to Cerros Island (lat. 28° N.) (Dall, 1921; Keen, 1937). Madsen (1949) gives the northern limit of this species as lat. 71° N. at Greenland and as Novaya Zemlya off Europe.

Genus *Musculus* Röding, 1793*Musculus niger* (Gray, 1824)

PLATE 18, FIGURE 6; PLATE 21, FIGURE 6

Modiola nigra Gray, 1824, p. 244.

Modiolaria nigra Jensen, 1912, p. 63.—Oldroyd, 1924, p. 74, pl. 39, fig. 9.—Morris, 1947, p. 25, pl. 12, fig. 5; 1952, p. 45, pl. 6, fig. 4.

Musculus niger obesus Dall, 1916, p. 405.

Musculus niger Abbott, 1954, p. 355, pl. 28g.

The largest living specimen collected, 50 by 23.3 by 11.6 mm., was cast ashore on Oct. 17, 1949. If entire, a broken valve taken at Eluitkak Pass would have measured about 56 mm. long by 27.5 mm. high. In addition to those listed below, several juvenile specimens were dredged at 477 feet.

Eighteen living specimens were dredged: 2 (10.1 and 11.2 mm. in length) at Eluitkak Pass on Aug. 10, 1948; 4 (3.3, 8.2, 8.5, and 10.5 mm.) at Eluitkak Pass on Aug. 30, 1948; 2 (11.2 and 12.4 mm.) at 151 feet; 2 (10.1 and 11.2 mm.) and 1 (30.2 by 16.5 by 8.5 mm.) at 204 feet; 1 (7.2 mm.) at 213 feet; 1 (7.2 mm.) at 216 feet; 1 (7.3 mm.) at 217 feet; 1 (12.5 by 7.3 by 4.4 mm.) at 341 feet; 1 (9.8 mm.) at 477 feet; and 2 (8.3 and 31.5 mm.) at 741 feet.

OTHER MATERIAL EXAMINED: Over 30 specimens from localities ranging from Bernard Harbor, Northwest Territories, Canada, and from near the mouth of the Colville River to Point Barrow and Icy

Cape, and south to Nunivak Island, the Aleutians, and Puget Sound; about 6 specimens (including the figured type) from the Shetlands, the British Isles, and Norway; and about 85 specimens from Greenland, Labrador, Maine, and south to Cape Hatteras.

DISCUSSION: The young of this species are olive green to brown and occasionally creamy tan; larger specimens vary from olive green to brown to black, with various mixtures of these colors—for instance, the center may be black and the anterior and posterior ends brown. There is some variation in the coarseness of the striae. The shells also vary in breadth from thin to relatively obese, the latter giving rise to Dall's *M. niger obesus*. There are all intergradations between the thin and the obese. In specimens from northwest Greenland, Grand Manan, Long Island Sound, and Isle au Haut, Maine, there are both thin and obese shells. Specimens from the north end of Nunivak Island vary from medium thin to obese.

A specimen 66 mm. in length from the north of Unimak Island has about 13 growth cessation lines, plus several secondary lines, one 37 mm. in length has from 7 to 9 growth cessation lines; and 2 specimens from west of the Colville River, measuring 49 mm. and 56 mm. in length, have 11 and 15 lines, respectively.

DISTRIBUTION: Throughout the Arctic; in the Pacific south to Oregon; in the Atlantic south to Cape Hatteras, N. C., and to Scotland.

Musculus corrugatus (Stimpson, 1851)

PLATE 4, FIGURE 11; PLATE 18, FIGURE 7; PLATE 21, FIGURE 4

Mytilus corrugatus Stimpson, 1851, p. 12 [no description but “=*Modiola discors* Gould”].

Modiolaria corrugata G. Sars, 1878, p. 30, pl. 19, figs. 2a-b.—Jensen, 1912, p. 62, pl. 3, figs. 7a-d.

About 40 specimens, mostly small, were dredged: 1 (17.8 by 10.9 by 6.9 mm.) from Eluitkak Pass on Aug. 1, 1950; 3 (4, 4.5, and 13.8 mm. long) from 130 feet on Aug. 9, 1949; 2 (5 and 12.7 mm.) from 184 feet; 1 (7.3 mm.) from 204 feet (pl. 4, fig. 11); 2 (8.6 and 12 mm.) from 213 feet; 2 (6 and 6.5 mm.) from 216 feet; 6 (from 3.5 to 10.5 mm.) from 217 feet; 2 (8.6 and 13.2 mm.) from 295 feet; 1 (13 mm.) from 341 feet; 17 (from 3.5 to 14.2 mm.) from 420 feet; 1 (13 mm.) from 438 feet; and 3 (5.8, 10.5, and 14.5 mm.) from 741 feet.

OTHER MATERIAL EXAMINED: 4 specimens from “north of Bering Strait,” 2 from Bernard Harbor, 3 from Dolphin and Union Straits.

DISCUSSION: The Point Barrow specimens vary in color, from a very pale greenish to an olive green, in the degree of inflation, and in the extent to which the basal margin of the posterior striated portion projects below the unstriated middle portion (pl. 18, fig. 7). There

is little evidence of this projection in specimens 8 mm. and less in length (pl. 4, fig. 11; pl. 21, fig. 4).

A specimen with a shell measuring 12.7 by 6.9 by 6 mm. that was taken at 184 feet on Aug. 30, 1949, was entirely enclosed within a byssal capsule, and within this capsule were a large number of embryonic clams still within their egg membranes but with definite valves developed. The egg membrane was from 20 to 55μ longer than the embryonic clams. Two of the embryos measured 389μ (434μ with the egg membrane), 5 measured 434μ (1 was 454μ long with the egg membrane), and 1 measured 462μ .

A specimen 13 mm. long is at least 3 years old.

DISTRIBUTION: Circumboreal. Arctic Ocean to Puget Sound (Dall, 1921); Jan Mayen (?), western Greenland (few), Iceland (?), Spitzbergen, Finmarken, Polar Sea of Siberia (Jensen, 1912); Greenland to North Carolina (Johnson, 1934).

Musculus discors (Linnaeus, 1767)

Var. laevigatus and *forma substriatus* Gray

PLATE 18, FIGURE 10; PLATE 21, FIGURE 5

Mytilus discors Linnaeus, 1767, ed. 12, p. 1159.

Modiola laevigata Gray, 1824, p. 244.

Modiola laevigata var. *substriata* Gray, 1824, p. 245.

Modiolaria laevigata G. Sars, 1878, p. 29, pl. 3, figs. 3a-b (good illustrations).

Modiolaria discors Jensen, 1912, p. 57, pl. 3, figs. 6a-b.

Modiolaria discors var. *laevigata* Jensen, 1912, p. 57, pl. 3, figs. 4a-b.

Modiolaria discors var. *substriata* Jensen, 1912, p. 58, pl. 3, figs. 5a-c.

Musculus discors Abbott, 1954, p. 355, pl. 28e.

Musculus laevigatus Abbott, 1954, p. 355, pl. 28f.

Varieties of this species, especially individuals up to 9 mm. in length, were fairly abundant in the deeper stations. The largest individual, 29 mm. long, came from 741 feet; 1 (21 mm.) came from 477 feet; 1 (14 mm.) from 453 feet; 2 (20 and 24.5 mm.) from 438 feet; 1 (24.6 by 16.1 by 9.4 mm.) from 175 feet; 1 (13 mm.) from 122 feet; 1 (28.9 mm.) from Eluitkak Pass on Aug. 1, 1950; 11 (from 7.6 to 11.2 mm.) from Eluitkak Pass on Aug. 30, 1948; and 3 (11.5, 16.5, and 23 mm.) from Eluitkak Pass on Aug. 6, 1948.

Smaller individuals were dredged as follows: 4 (up to 5 mm.) at 130 feet on Aug. 9, 1949; 1 (about 3 mm.) at 152 feet; 5 (up to 11 mm.) at 175 feet; 3 (up to 6 mm.) at 184 feet; 1 (3 mm.) at 420 feet; about 30 (up to 9 mm.) at 438 feet; 8 (up to 13.5 mm.) at 453 feet; about 100 (from 2 to 13.2 mm.) at 477 feet; and 18 (from 3 to 15.5 mm.) at 741 feet.

Juveniles up to 9 mm. in length were frequently found attached to erect colonies of bryozoans. For example, 3 specimens (up to 6 mm. long) were found attached to *Tricellaria erecta* at 184 feet; 1 (10 mm.)

was found nestled in *Barentsia gorbunovi* at 341 feet; about 30 (up to 9 mm.) were attached to *B. gorbunovi* at 438 feet; and a small individual was found nestled in the tunic of *Boltenia echinata*.

Most of the larger individuals were encased in a capsule of byssal threads, but no individual less than 13.5 mm. long was found in a byssal capsule. In one encapsulated specimen (20.4 by 12.6 by 8.1 mm.) from Eluitkak Pass, stolons of hydroids were interlaced through the byssal threads and among this network were nestled a *Hiatella arctica* 6.6 mm. long, an annelid worm about 7 mm. long, and 2 sipunculids, *Golfingia margaritacea*, about 5 and 7 mm. long. One specimen 22.5 mm. long that was taken from 328 feet was in a capsule that was covered with a colony of the bryozoan *Dendrobeania murrayana*, which, in turn, provided space for colonies of 2 other bryozoans, 2 species of hydroids, some sponges, foraminifers, and a *Hiatella arctica* 5.8 mm. long.

Another specimen 22.4 mm. long from 328 feet (Sept. 1, 1949) was encased in a byssal net to which were attached colonies of a bryozoan, and attached to this mass was a *Musculus discors* var. *laevigatus* 2.2 mm. long and another smaller one. A large encapsulated individual was taken at 341 feet. The smallest encapsulated individual (13.5 mm.) taken at 453 feet, was attached to the stalk of the tunicate *Boltenia ovifera*. Two others (15 and 17.5 mm. long) from 453 feet were in capsules to which were attached colonies of *Barentsia gorbunovi* and *Eucratea loricata* with their attached fauna. Two (19.5 and 21 mm.) from 477 feet were in capsules matted with nematodes, and tiny sponges and small colonies of *Eucratea loricata* were attached to one of the cases. Only a portion of these capsules was opened, but no eggs were found in those examined.

OTHER MATERIAL EXAMINED: About 50 specimens from localities ranging from Bernard Harbor, Northwest Territories, and Icy Cape, Alaska, south and east to the Aleutians and Puget Sound; and over 75 specimens from localities ranging from the Melville Peninsula and Greenland to Connecticut, and from Spitzbergen and Norway. (Two from between Bristol Bay and the Pribilofs and one from Sitka Harbor were in byssal capsules.)

DISCUSSION: There has been considerable difference of opinion regarding this species and its varieties. Jensen (1912) has shown that *M. laevigatus* Gray and *M. substriatus* Gray are not distinct species. The former is a variety of *M. discors* (see Jensen, 1912, pl. 3, figs. 6a-b) in which the posterior striations are lacking (Jensen, 1912, pl. 3, figs. 4a-b) and *M. substriatus* is merely a form of var. *laevigatus* in which the posterior striations are visible but faint (Jensen, 1912, pl. 3, figs. 5a-c). In true *M. discors* the posterior striations are distinct, as in *M. corrugatus* (Jensen, 1912, pl. 3, figs. 7a-d), but in *M. discors*

and its varieties the central portion of the shell between the posterior and anterior striations is much smoother (pl. 18, fig. 10) than in *M. corrugatus*; in the former the periostracum of this central area has delicate, simple, transverse lines but in *M. corrugatus* it is wrinkled and shagreen-like. In adults, both the posterior and anterior striations are more numerous in *M. niger* than in the other two species, and the posterior striations of *M. corrugatus* are more numerous than those of *M. discors* var. *laevigatus* f. *substriatus*.

Color, on which certain varieties and species have been based in the past, is a very unreliable characteristic in this group. In the specimens examined, all gradations of color from a pale olive green through browns to a shiny black (Plover Bay) were found. Several are a mixture of brown and black. Very young specimens from Point Barrow are a pale yellowish green.

Juvenile specimens of *M. discors* and its varieties are difficult to separate from those of *M. corrugatus* and *M. niger*, for all of them have both anterior and posterior striations on the shells. The young of *M. discors* var. *laevigatus* are usually more inflated than those of *M. corrugatus*, and the latter are more inflated than those of *M. niger*. The umbos of juvenile *M. corrugatus* are prominent (pl. 21, fig. 4). The ventral margin of juvenile *M. corrugatus* is fairly straight (pl. 21, fig. 4), that of *M. niger* is somewhat convex (pl. 21, fig. 6), while that of *M. discors* var. *laevigatus* is somewhat more arcuate and the first posterior striation projects somewhat (pl. 21, fig. 5). The dorsal margin of juvenile *M. niger* ascends posteriorly more rapidly from the umbos (pl. 21, fig. 6) than in *M. discors* var. *laevigatus* (pl. 21, fig. 5).

The degree to which the posterior striations fade out in the varieties of *M. discors* as growth proceeds farther from the umbos is highly variable. Some shells were observed in which no indication of striations could be seen beyond the first year growth line and in others the striations persisted, though less marked, to the second year growth line. In others faint striations could be seen in adult specimens and in a few the striations fade out in the middle portion of the posterior end and appear again near the margins.

The Point Barrow specimens belong to the var. *laevigatus* and a few of them could be assigned to the forma *substriatus*. This substantiates Jensen's (1912) statement that he has not found a true *M. discors* in the Arctic. I am indebted to Dr. Thorson and Mr. W. K. Ockelmann for sending me specimens of true *M. discors*, *M. discors* var. *laevigatus*, and *M. discors* var. *laevigatus* forma *substriatus*, as well as specimens of *M. corrugatus*.

Thorson (1935) states that in eastern Greenland *M. discors* var. *laevigatus* draws together blades of *Fucus* or *Laminaria* by means of

byssal threads and thus encased with the seaweed and byssal threads lays a string of eggs that develop into young clams within the seaweed-byssal "nest." At Point Barrow there are no seaweeds that could be used in this manner and the animal makes its capsule entirely of byssal threads. I examined 3 specimens of var. *laevigatus* from the northeast end of the Melville Peninsula and 3 from the south end that were in byssal nests with pieces of *Ulva*-like alga attached.

The Pacific specimens of varieties of *M. discors* usually have been listed under the specific names of *Modiolaria laevigata* and *M. substriata* by Western authors.

DISTRIBUTION: Varieties of *M. discors* are found throughout the Arctic and as far south as Japan and Puget Sound in the Pacific and New York and Madeira in the Atlantic. As at Point Barrow, the var. *laevigatus* is more common in both eastern and western Greenland and in Iceland than the forma *substriatus* (Jensen, 1912; Madsen, 1949).

Order ANOMALODESMACEA

Family THRACIIDAE

Genus *Thracia* Blainville, 1824

Thracia myopsis (Möller, 1842, ex Beck MS.)

PLATE 23, FIGURE 9; PLATE 24, FIGURE 4

Thracia myopsis Möller, 1842a, p. 18; 1842b, p. 94.—Soot-Ryen, 1941, p. 38' pl. 2, figs. 1-4; pl. 6, figs. 3a-b; pl. 8, figs. 4a-e.

Thracia curta Dall, 1921, p. 25 (in part).—Oldroyd, 1924, p. 84 (in part).

One right valve 30.5 mm. long and 24.3 mm. high was taken at 217 feet, and 1 entire (only recently vacated) shell 30 mm. long and 22.5 mm. high was taken at 341 feet.

OTHER MATERIAL EXAMINED: A number of specimens from Icy Cape, Cape Sabine, Plover Bay, off Bristol Bay, Amchitka Island, Atka Island, and Port Etches (all of which were labeled *T. curta*). Also several specimens (labeled *T. myopsis*) from Bergen and Vadsø, Norway, from Spitzbergen, and from Greenland and Maine.

DISCUSSION: The Point Barrow specimens correspond with those examined from Bergen and Vadsø. Those from Greenland and Spitzbergen are a trifle more elongate, a trifle more angular, and somewhat more abruptly truncate. The specimens from Maine are somewhat higher and more truncate and have a somewhat shorter posterior end.

In examining specimens of *Thracia*, it was found that those from Port Etches and northward are *T. myopsis* and those from Lituya Bay and Sitka and on south are *T. curta* Conrad. The northernmost range of *T. curta* thus becomes Lituya Bay (about lat. 58.5° N. instead of lat. 71° N.). In *T. curta* the beaks are more posteriorly placed and

there is more inequality of the valves than in *T. myopsis*. There is also more of a dip in the anterodorsal margin in *T. curta* than in *T. myopsis*.

DISTRIBUTION: Point Barrow south to the Aleutians and Port Etches (about lat. 60.3° N., long. 146.3° W.), also Plover Bay, Siberia. Madsen (1949) gives the Atlantic range of *T. myopsis* as northeastern America south to Massachusetts; Greenland; Iceland, Norway north of Bergen, and Spitzbergen to the Kara Sea. It is new to the Pacific and the Pacific area of the Arctic.

Thracia (Lampeia), new subgenus

TYPE SPECIES: *Thracia adamsi*, new species.

Shell small, inequivalve, ovately-subquadrate, rounded anteriorly, broadly truncate posteriorly, anterior end longer than posterior, right valve higher and more convex than left; ligament external, thin; hinge edentate; resilium large, elongate-trigonal; with a large buttressed resilifer tapering posteriorly beneath the beaks.

The buttressed resilifer distinguishes this group from others of the family.

REMARKS.—This subgenus probably belongs close to subgenus *Thracia* (*Thracia*). It is named in honor of Mr. Chester Lampe, head Eskimo employee at the Arctic Research Laboratory, Point Barrow base, Alaska.

Thracia adamsi, new species

PLATE 18, FIGURE 9; PLATE 21, FIGURES 7, 8; PLATE 24, FIGURE 8

Shell small, white, inequivalve, right valve higher and deeper than left; covered with a fairly thick brown periostracum; beaks directed posteriorly; posterior end the shorter, broadly subtruncate, with a faint radial ridge bearing along the lower two thirds a few microscopic spinelets and a suggestion of a second row of spinelets midway of the area posterior to the ridge; anterior end obtusely rounded; ventral margin only slightly convex; periostracum smooth in center and finely wrinkled near the margins; sculpture of faint concentric lines of growth; ligament external, thin; resilium large, elongate-trigonal; a large, elongate-trigonal resilifer extending in an obliquely posterior direction from the beaks, solidly attached to the shell throughout its length except near its anteroventral margin where it is buttressed by about 15 short pillars separated by shallow pits of about the same width as the pillars, and separated from the anterodorsal edge of the shell by a large, deep pit. Interior of shell chalky; posterior adductor muscle scar large, rounded; anterior, large, elongate. Central portion of pallial line somewhat wavy; pallial sinus of medium size, broadly

U-shaped in the left valve, rounded and somewhat larger in the right valve; lower edge of pallial sinus scar not confluent with pallial line.

DIMENSIONS: Holotype, closed shell, length, 22.8 mm., height, 18.1, depth, 9.19; right valve, height, 18.3 mm., depth, 6.1; left valve, height, 17.3 mm., depth, 4.4.

REPOSITORY: Holotype in U. S. National Museum, No. 610301.

TYPE LOCALITY.—About 2.5 miles off Point Barrow base, Alaska. Depth, 110 feet. Bottom: stones, mud, gravel (haul containing many *Psolus fabricii* (sea cucumber) and sea anemones, mostly *Stomphia coccinea*). Collected by G. E. MacGinitie, Sept. 15, 1948.

REMARKS: Although this shell was empty, the right valve had apparently been drilled only recently. The posteroventral margin is somewhat shortened by breakage. This species is named in honor of Mr. Max Adams, an Eskimo who served G. E. MacGinitie as head boatman during the summer of 1948.

Family LYONSHIDAE

Genus *Lyonsia* Turton, 1822

Lyonsia norvegica (Gmelin, 1790)

Mya norvegica Gmelin, 1790, p. 3222.

Mya striata Montagu, 1815, p. 188, pl. 13, figs. 1 and A.

Lyonsia norvegica Jeffreys, 1865b, p. 29, pl. 2, fig. 1 (good illustration).

One specimen with a shell 36.3 mm. long and 19.4 mm. high was taken at 420 feet. It appeared to be about 2½ years old. A portion of a valve 17.4 mm. high was taken at 328 feet.

OTHER MATERIAL EXAMINED: Over 100 specimens from the Shetlands, Ireland, the Hebrides, and the Mediterranean.

DISCUSSION: The Point Barrow specimens are less transparent than the other material examined. (Several species of shells from Point Barrow are more chalky and less transparent than the same species from other localities.)

DISTRIBUTION: Point Barrow south to Juan de Fuca Strait; from Lofoten, Norway, south to the Mediterranean, from the Shetlands, the Faroes, and Iceland.

Order TELEODESMACEA

Suborder DIOGENODONTA

Family ASTARTIDAE

Genus *Astarte* Sowerby, 1816

Species in this genus are extremely variable, with the result that some of them have been redescribed many times and endless varieties have been named, these species and varieties being based on such

highly variable characters as color and the relative coarseness of concentric ribs. Both Lamy (1919) and Dall (1903a) made revisions of this genus, but Lamy did not have access to many of the Pacific species, and Dall, like the present writer, did not have access to many European species; and by the time their revisions were made the species were so hopelessly confused in the literature that the only way to straighten them out would be to see the specimens on which the various papers were based. Jensen's work (1912) on several species was an excellent contribution.

Astarte borealis Schumacher, 1817

PLATE 22, FIGURES 1-6

Astarte borealis Schumacher, 1817, p. 47, pl. 17, fig. 1.—Dall, 1903a, pp. 941, 944.—Jensen, 1912, p. 92, pl. 4, figs. 1a-f.—Soot-Ryen, 1939, p. 10, pl. 1, figs. 1-3.—Morris, 1952, p. 33, pl. 8, fig. 21.—Abbott, 1954, p. 375, pl. 28q.—Kira, 1954, p. 105, pl. 52, fig. 22.

Astarte arctica Möller, 1842a, p. 20; 1842b, p. 93.

Astarte semisulcata Möller, 1842a, p. 19; 1842b, p. 92.

Astarte richardsoni Reeve, 1855, p. 397, pl. 33, figs. 7a, b.

Approximately 40 specimens (including empty shells) were dredged. About one half of this number came from Eluitkak Pass and at least half of them were empty shells. The remaining specimens and shells came from 11 stations ranging in depth from 80 feet (Sept. 8, 1948) to 438 feet. With the exception of the station at 295 feet, with 5 specimens, no station other than Eluitkak Pass yielded more than one or two. The largest living specimen (54 mm. long by 43 mm. high by 20.4 mm. in breadth) came from Eluitkak Pass; two other shells from Eluitkak Pass and 1 from 295 feet exceed 50 mm. in length, and at least 22 others exceed 40 mm. in length. The 3 smallest specimens are: 1 (14.5 by 11.5 by 5.4 mm.) from 118 feet; 1 (13 by 11 by 10 mm.) from 341 feet; and 1 (17.5 by 13 by 6 mm.) from 295 feet. The complete absence of very small specimens is worthy of note.

Empty shells were usually filled with mud and were so tightly closed that it was impossible to distinguish empty from living shells without opening them. Since the umbos of living shells were often as worn and eroded as those of dead shells, the external appearance was no criterion.

OTHER MATERIAL EXAMINED: Over 100 specimens from the following localities: Franklin Bay, Icy Cape, Plover Bay, Bering Sea, and the Kudobin Islands; Wellington Channel, Cumberland Gulf, the Grand Banks, and Labrador; and Novaya Zemlya.

DISCUSSION: The Point Barrow shells vary in color from light brown to black, sometimes with combinations of the two colors in the same shell. Some, even living ones, have a rustlike deposit or con-

cretion on portions of the shell, especially the anterior end. There is great variation in the proportion of the length to the height, and in the general shape of the shell: 1 (44.8 by 35 by 14 mm.) from Eluitkak Pass is typical in both shape and dimensions; another (40.8 by 31.9 by 12.6 mm.) from Eluitkak Pass (Aug. 1, 1950) is an elongate shell in which the posterior end is more pointed and extended than usual (pl. 22, fig. 6); still another (42.3 by 36.7 by 12.6 mm.) from Eluitkak Pass (Aug. 10, 1948) has both anterior and posterior ends, as well as the ventral margin, slightly more rounded than usual (pl. 22, fig. 2). In another specimen (40.6 by 34.4 by 17.1 mm.) from Eluitkak Pass the posterior end is shortened and truncated, the result of habitat and the vicissitudes of life, and the umbos are completely eroded away. In a specimen from 152 feet the shell is box-like along the ventral margin (also see *Cardita crassidens*). Some of the variations in shape and proportions are shown by Soot-Ryen (1939, pl. 1, figs. 1-3), and variations in sculpture as well as shape are described and figured by Jensen (1912, pl. 4, figs. 1a-f).

In many of the shells the concentric ribs around the umbos do not continue for more than 7 or 8 mm. before being replaced by fine concentric lines, but in others these ribs may extend toward the ventral margin for a distance of 12 mm. or more. In most the transition from ribs to fine lines is abrupt, but in some it is less marked.

The hinge is also a highly variable character, the teeth and fossae vary in size and shape, and minor protuberances may be present or absent. The chalkiness characteristic of many Arctic shells often makes the teeth appear large and coarser than usual. Ridges, depressions, and fossae on the inside of the shell also vary greatly in size and shape.

Shells examined from other localities exhibit the same variations as the ones from Point Barrow, many having the convex lower border, others with the posterior end produced, and others with a shortened posterior end. Shells from the same locality may exhibit all of these variations, or in any combination, and all types of intergrades are found.

Growth cessation lines are indistinct in this species, but shells from 45 to 50 mm. long are probably from 6 to 8 years old.

DISTRIBUTION: MacFarlane Bay near the mouth of the Mackenzie River, Point Barrow, south to the Aleutians and Prince William Sound, the Sea of Okhotsk, also northern Japan; in the Atlantic area south to Massachusetts and Rhode Island; Greenland and Iceland; Franz Josef Land, Novaya Zemlya, and northern Europe south to Bergen, Norway.

Astarte montagui (Dillwyn, 1817)

Varieties

PLATE 22, FIGURES 11-16

- Venus compressa* Montagu, 1808, suppl., p. 43, pl. 26, fig. 1. [Preoccupied.]
Venus montagui Dillwyn, 1817, p. 167.
Nicania banksii Leach, 1819, appendix 2, p. 62.
Nicania striata Leach, 1819, appendix 2, p. 62.
Astarte striata J. Gray, 1839, p. 152, pl. 44, fig. 9.
Astarte banksii J. Gray, 1839, p. 152, pl. 44, fig. 10 (= f. *warhami*).
Astarte globosa Möller, 1842a, p. 19.—Reeve, 1855, p. 398, pl. 33, figs. 6a-b.
Astarte pulchella Jonas, 1845, in Philippi, 1844-1847, p. 60, pl. 1, *Astarte*, fig. 12.
Astarte warhami Hancock, 1846, p. 336, pl. 5, figs. 15, 16.
Astarte fabula Reeve, 1855, p. 398, pl. 33, figs. 5a-b.—Oldroyd, 1924, p. 107, pl. 19, figs. 4, 4a.—Morris, 1952, p. 33, pl. 8, fig. 22.
Astarte montagui Jensen, 1912, p. 97, pl. 4, figs. 2a-c.

After *Hiatella arctica*, and possibly *Macoma calcarea*, this was the most abundant bivalve collected at Point Barrow. It was taken at depths of 80 to 741 feet. The most important collecting data are given below:

Three individuals (from 18.2 to 22.5 mm. in length) were dredged from 80 feet (Aug. 21, 1948); 7 (from 18.8 to 24.2 mm.) from 120 feet (Aug. 8, 1949); 9 (from 9.3 to 20.7 mm.) from 138 feet; 10 (from 7.7 to 20.2 mm.) from 149 feet; 13 (10 from 7.3 to 10.8 and 3 from 16.5 to 20.6 mm.) from 162 feet; 7 (from 12.9 to 24.1 mm.) from 204 feet; 12 (from 7.4 to 26 mm.) from 216 feet; 38 (from 5.5 to 26.7 mm.) from 217 feet; (from 12.1 to 35 mm.) from 246 feet; 12 (from 16.9 to 25.2 mm.) from 295 feet; 32 (from 10.1 to 25.5 mm.) from 341 feet; 25 (from 10.2 to 24.4 mm.) from 420 feet; 40 (from 11.9 to 24.4 mm.) from 453 feet; and 8 (from 6.5 to 16.6 mm.) from 741 feet.

OTHER MATERIAL EXAMINED: Over 20 specimens (labeled *A. fabula*) from localities ranging from Icy Cape to British Columbia.

DISCUSSION: Jensen (1912) separated the varieties of *A. montagui* by the statistical method. In his selected types, the height divided by the length in forma typica gave 92.9 percent; in var. *striata*, 86.7 percent; and in var. *warhami*, 76.1 percent. The breadth divided by the length in forma typica gave 53.6 percent; in the var. *striata*, 53.3 percent; in the var. *warhami*, 43.2 percent; and in the var. *globosa* percentages in the 60's. Although the height:length percentages range in the 90's in forma typica, in the 80's in var. *striata*, and in the 70's in var. *warhami*, there is no sharp dividing line and some shells could as easily be assigned to one variety as to another. Jensen (1912) states ". . . it must be remembered that all possible transitional stages exist between the forms mentioned."

Jensen (1912) writes that var. *striata* is by far the most predominant form at western Greenland, with var. *globosa* occurring frequently, the typical form and var. *warhami* being comparatively rare. He also states that *A. montagui* "becomes elongated on the whole in the same degree as the marine climate becomes more severe," the typical form being found in the Faroes and southwest Iceland, the var. *striata* beginning to appear at the northern end of western Iceland; at western Greenland the var. *striata* predominates and the more elongate *warhami* begins to appear, whereas at eastern Greenland the var. *warhami* is almost the only form.

The findings at Point Barrow agree with Jensen's observations, for the great majority of the *A. montagui* from there belong to the var. *warhami* Hancock (pl. 22, figs. 11, 12) and there are no true forma typica. A much lesser number can be assigned to the var. *fabula* Reeve, a few to the var. *striata* Leach (see pl. 22, fig. 14), and one or two approach the dimensions of var. *globosa* Möller. The largest specimen, from a depth of 246 feet, measures 35 by 29.6 by 17.1 mm. It has the periostracum of *A. montagui* and the shape of var. *striata* but the shell is exceptionally large for either the typical form or the variety. The next largest is a var. *warhami* measuring 27.2 by 21 by 11.4 mm. Jensen found that accompanying the elongation of the form there is an increase in maximum length from around 19–20 mm. at the Faroes and western Iceland to 23–26 mm. at eastern Iceland and Greenland. The majority of the larger specimens from Point Barrow come within the 23–26 mm. range. Specimens from any large haul usually have representatives of the varieties *warhami*, *fabula*, and *striata*, with intergrades (pl. 22, figs. 15, 16).

There is as much variation in sculpture as in shape. The most common sculpture consists of prominent, evenly spaced, concentric riblets (with about equal interspaces) in the umbonal region, with less prominent, irregularly spaced, concentric riblets throughout the lower two thirds of the shell or with fine lines that give the shell a smooth appearance, but in some shells the umbonal sculpture extends to the ventral margin, and in others the umbonal sculpture is only slightly more prominent than that throughout the remainder of the shell.

The color ranges from a yellowish tan to a dark chestnut brown. In some shells a black deposit covers part or sometimes nearly all of the periostracum. The latter sometimes cracks and peels away from the shell and the shell itself sometimes cracks.

Like *A. borealis*, this species closes so tightly that it is difficult to insert a razor blade between the valves.

Yearly age lines are not so conspicuous in this species as in some of the other Point Barrow shells. A shell 7.3 mm. long appears to be

from 1 to 2 years old; one 10.8 mm., about 2 years; one 16.5 mm., about 4 years; and one 20.6 mm., about 5 years old. There is some evidence indicating that if a large series were available from one locality, they could easily be sorted into age groups on the basis of size.

In the specimens taken at 453 feet on Oct. 11, 1949, the females greatly outnumbered the males. The females contained eggs that were not quite mature, measuring about 292μ , including the membrane. Of 9 specimens taken through the ice at 162 feet on Feb. 18, 1950, 3 were so immature that the sex could not be determined without making sections, 4 were males with fairly well developed testes, 1 had immature eggs, and 1 had some fairly well developed eggs. Six of the eggs from the latter specimen measured 324, 316, 291.5, 283.4, 283.4, and 234.9μ , an average of 288μ ; the yolk portion measuring from 105.3 to 218.7μ , and averaging 162μ .

This species forms a favorite food of *Natica* and *Polinices* and drilled shells are common in dredge hauls.

DISTRIBUTION: *A. montagui* occurs in all Arctic seas; in the Pacific as far south as British Columbia; in the western Atlantic as far south as Massachusetts, and in the eastern Atlantic as far south as the Bay of Biscay. Point Barrow is a new locality. This is a new name in our list of Pacific mollusks.

Family CARDITIDAE

Genus *Cardita* Lamarek, 1799

Cardita crebricostata (Krause, 1835)

Cardita borealis var. *crebricostata* Krause, 1835a, p. 30, pl. 3, fig. 4.

Venericardia alaskana Dall, 1903b, pp. 710, 715; 1903a, pl. 63, fig. 7.

Venericardia crebricostata Oldroyd, 1924, p. 114, pl. 13, fig. 12.

Two worn right valves, measuring 27.2 mm. long by 24.5 mm. high, and 29.6 by 25.9 mm., were taken at 140 feet on Aug. 21, 1949, and a somewhat broken valve was washed ashore.

OTHER MATERIAL EXAMINED: All the specimens in the U. S. National Museum labeled *V. alaskana* and *V. crebricostata*.

DISCUSSION: With the exception of 3 specimens from the vicinity of Monterey, all of the specimens labeled *C. alaskana* are *C. crebricostata*. Specimens from Puget Sound and the coast of Oregon conform to the specifications for *C. crebricostata*, but those from Monterey are probably *C. ventricosa*.

DISTRIBUTION: Point Barrow south and east to the Aleutians, British Columbia, Puget Sound, and the coast of Oregon.

Cardita crassidens (Broderip and Sowerby, 1829)

PLATE 22, FIGURES 7-10

Astarte crassidens Broderip and Sowerby, 1829, p. 365.

Cardita borealis var. *paucicostata* Krause, 1885a, p. 30, pl. 3, fig. 5.

Venericardia crassidens Dall, 1903a, p. 949, pl. 63, fig. 9.

Venericardia paucicostata Oldroyd, 1924, p. 112, pl. 13, fig. 3.—Kira, 1954, p. 105, pl. 52, fig. 21.

Approximately 35 specimens were collected from 18 stations ranging in depth from 80 to 477 feet; the greatest number from any one station was 8 from 341 feet. The largest shell measures 36.4 mm. long by 37.2 mm. high by 18.9 mm. in breadth, and the next largest is 35 by 38 by 17.8 mm. Other than the smallest specimens, the majority range between 20 and 35 mm. in height. Small specimens were collected as follows: 1 (3.5 by 3.2 by 1.9 mm.) from 216 feet; 3 (ranging from 1.6 to 2.2 mm. in length) and 1 (3.3 by 3 by 1.8 mm.) from 184 feet; 1 (4.6 by 4.4 by 2.5 mm.) from 152 feet; and 4 (2.4, 3, 8, and 9.1 mm.) from 341 feet.

The gonads of a specimen collected at 341 feet on Oct. 11, 1949, contained eggs measuring up to 761.4μ (the average being 753μ). Since there was only a thin, crystalline layer around the egg, most of the egg consisted of yolk. With such a large, yolky egg, it seems probable that *C. crassidens* is ovoviviparous.

OTHER MATERIAL EXAMINED: About 25 specimens from localities ranging from Icy Cape and the Sea Horse Islands, Bering Strait and Plover Bay to Kodiak Island.

DISCUSSION: Like the Point Barrow shells, these specimens vary from those that are longer than high to those that are higher than long, and have a periostracum ranging from a yellowish light brown to an olive brown, and in others the shells are so eroded that the periostracum is lacking. In some the broad ribs are clearly visible to the ventral margin, in others the shell is so coarse and eroded that little ribbing is discernible except in the region of the umbos. Internal crenations are visible even in the most misshapen shells.

In young specimens the length exceeds the height (pl. 22, fig. 9), but in adults the height usually exceeds the length (pl. 22, fig. 7). In those adults in which the length exceeds the height, the height has often been foreshortened by growing in a rugged environment that prevents the shell assuming a normal shape and the ventral margin grows inward instead of ventrad. One specimen from 130 feet (Aug. 9, 1949) with a shell 23.3 by 25.6 by 15.4 mm. has the ventral and anteroventral (the latter somewhat subtended) margins turned in to such an extent that the breadth at the ventral margin is as great as anywhere throughout the extent of the shell, making the shell boxlike (see pl. 22, fig. 10).

Cardita paucicostata is the young of *C. crassidens* or a *C. crassidens* that has been favored by fate. When the latter species does not grow in cramped quarters and does not become eroded and covered with other animals, it shows the same color and texture of periostracum attributed to *C. paucicostata*, and the length tends to remain equal to the height.

A shell from Point Barrow that is 24 mm. long by 22 mm. high is about 4 years old, and another 24 mm. long by 20 mm. high is about 5 years old.

DISTRIBUTION: Point Barrow to Puget Sound. Point Barrow is a new locality.

Family THYASIRIDAE

Genus *Thyasira* Lamarck, 1818

Thyasira flexuosa (Montagu, 1803)

Var. *sarsi* Philippi

PLATE 4, FIGURE 12

Tellina flexuosa Montagu, 1803, p. 72.

Lucina flexuosa Gould, 1841, p. 71, fig. 52.—*flexuosa* Philippi, 1845a, p. 74.

Lucina gouldii Philippi, 1845a, p. 75, pl. 2, fig. 7.

Axinus sarsi Philippi, 1845b, p. 91.—G. Sars, 1878, p. 60, pl. 19, figs. 6a-b.

Cryptodon gouldii Gould, 1870, p. 100, fig. 406.

Axinus flexuosus G. Sars, 1878, p. 59, pl. 19, figs. 4a-b.

Axinus gouldii G. Sars, 1878, p. 60, pl. 19, figs. 6a-b.

Thyasira gouldii Morris, 1952, p. 36, pl. 8, fig. 15.

A single living specimen 6.2 mm. long by 6.2 mm. high was dredged through the ice on Feb. 18, 1950, at a depth of 162 feet.

OTHER MATERIAL EXAMINED: Numerous specimens of var. *gouldi* from Norway, Spitzbergen, Iceland, Greenland, Nova Scotia, and Massachusetts; over 50 specimens of var. *gouldi* from localities ranging from Bering Strait to Juan de Fuca Strait and off Point Loma, Calif.

DISCUSSION: Madsen (1949) states that it is common practice to regard *T. gouldi* and *T. sarsi* as forms of *T. flexuosa* and Soot-Ryen (1932) treats them as such. Typical *T. flexuosa* and forma *gouldi* are higher in proportion to the length than forma *sarsi*. Both *T. flexuosa* and forma *gouldi* are somewhat truncate on the anteroventral border, whereas forma *sarsi* is evenly rounded (pl. 4, fig. 12). However, in a lot of about 30 specimens (Stanford collection) from Maine labeled *T. gouldi*, there are a few specimens that are evenly rounded antero-ventrally. Madsen (1949) further states that the "form common in Iceland is the American *gouldi*," but that a few large specimens have the *sarsi* form.

The specimen from Point Barrow is definitely the *sarsi* and not the *gouldi* form, being as long as high and evenly rounded on the anteroventral border.

DISTRIBUTION: *T. flexuosa*, including the forms *sarsi* and *gouldi*, occurs from Point Barrow south to San Diego, Calif.; in the western Atlantic it occurs as far south as Connecticut; it is widely distributed in the eastern Arctic, extending along the coast of Europe and into the Mediterranean. The form *gouldi* has been reported from Bering Strait to San Diego and from Greenland to Connecticut; Iceland and Europe. Forma *gouldi* occurs on both our east and west coasts, and forma *sarsi* occurs at Point Barrow.

Genus *Axinopsida* Keen and Chavan, 1951

Axinopsida orbiculata (G. O. Sars, 1878)

PLATE 20, FIGURE 2

Axinopsis orbiculata G. Sars, 1878, p. 63, pl. 19, figs. 11a-d.—Soot-Ryen, 1939, p. 14, pl. 1, fig. 7.

A single specimen, measuring 3.2 mm. long by 3.4 mm. high, was dredged at 120 feet on Aug. 8, 1949.

OTHER MATERIAL EXAMINED: About 34 specimens from localities ranging from Cumberland Gulf to off Cape Cod, Mass.; also over 20 specimens of the var. *inaequalis* Verrill and Bush from Nova Scotia, Maine, and near Cape Cod.

DISCUSSION: This species is higher in proportion to its length than *A. viridis* Dall, which some authors have suggested may be synonymous with *A. orbiculata*. In the latter the concavity in front of the beaks is greater and the posterodorsal margin slopes more rapidly than in *A. viridis*. The ventral margin of *A. viridis* comes to more of a point than in *A. orbiculata*. However, these differences are not marked and further study may show that *A. viridis* is only a variety of *A. orbiculata*.

DISTRIBUTION: Madsen (1949) says that *A. orbiculata* is widely distributed in the Arctic; on the east coast of America south to Cape Cod; off Norway to just south of Lofoten, and north of the Hebrides. *A. orbiculata* is new to Alaska and the Pacific area of the Arctic.

Family UNGULINIDAE

Genus *Diplodonta* Bronn, 1831

Diplodonta aleutica Dall, 1901

Diplodonta aleutica Dall, 1901, p. 820, pl. 42, fig. 3.

A single specimen of what is probably the very young of this species was taken at 741 feet on Aug. 17, 1949; it measures 2.5 mm. long by 2.3 mm. high.

DISTRIBUTION: Point Barrow, Cape Lisburne, Aleutian Islands, and Sitka Bay, Alaska. Point Barrow is a new locality and represents an extension of range of over 2 degrees of latitude.

Family LEPTONIDAE

Genus *Pseudopythina* Fischer, 1878

Pseudopythina compressa Dall, 1899

PLATE 19, FIGURES 2, 3, 5

Pseudopythina compressa Dall, 1899, p. 888, pl. 87, figs. 1, 8.—Oldroyd, 1924, p. 136.

A specimen measuring 11.6 mm. long by 8.5 mm. high and 3.3 mm. in breadth washed ashore on Aug. 27, 1949, and a right valve 6.8 by 4.9 mm. washed ashore on Oct. 16, 1949.

OTHER MATERIAL EXAMINED: The type (from 23 fathoms from southwest of Hagemeister Island) and 18 shells and 5 valves from 17 stations, including Cape Lisburne (3 dead shells), Norton Sound (1 dead shell), Numivak Island, the Aleutians, the Shumagins, Kodiak Island, Sitka Harbor, British Columbia, La Jolla, California, and off Acapulco, Mexico. With the exception of about 4 specimens, all of these were dead and sometimes beach-worn shells.

DISCUSSION: Oldroyd's (1924) figure 11 of plate 11 is of *P. rugifera* and not of *P. compressa* as labeled. This error, coupled with the fact that Dall, in his description of *P. compressa*, failed to call attention to the spinules on the dorsal margin of the right valve, has resulted in some workers trying to separate, on the basis of minute differences, specimens of *P. rugifera* into *P. rugifera* and *P. compressa*, when, in actuality, the two species are quite distinct. One of the specimens figured here (pl. 19, fig. 2) has 4 spinules on the dorsal margin posterior to the beaks and one anterior to the beaks. The number of these spinules is greater in large specimens than in small specimens.

DISTRIBUTION: Point Barrow south through Bering Sea and east and south to British Columbia; off the Columbia River, Oregon, off southern California, and off Baja California, Mexico. Point Barrow is a new locality.

Genus *Mysella* Angas, 1877

Mysella sovaliki, new species

PLATE 4, FIGURE 10

Shell minute, white, subelliptical, tumid, sturdy for its size, covered with a pale tan periostracum; posterior margin rather abrupt, anterior gently sloping, ventral margin convex, anteroventral margin somewhat produced, evenly rounded. Beaks very low, located about two-thirds the distance back from the anterior end. Sculpture of

fine concentric incremental lines, with about 6 growth-cessation lines. Teeth (as for the genus: 2 in right valve, none in left) large for size of shell, subequal. Muscle scars rounded, pallial line even.

DIMENSIONS: Holotype, length 2.3 mm.; height, 1.9 mm.; depth, 1.4 mm.

TYPE LOCALITY: About 12.1 miles off Point Barrow base, Alaska. Depth, 741 feet. Bottom, mud (haul containing mostly terebellid worm tubes, chiefly *Pista maculata*). Collected by G. E. MacGinitie, Aug. 17, 1949.

REPOSITORY: Holotype in U. S. National Museum, No. 610302.

OTHER LOCALITIES: Three specimens (labeled *Montacuta dawsoni*; USNM 170490) from Greenland.

REMARKS: The resilium of this specimen is missing. This species belongs near *M. tumida*. It is more tumid and more trigonal than the latter, and the posterior tooth is not so elongate as that of *M. tumida*. It is named in honor of Mr. Pete Sovalik, an Eskimo assistant at the Arctic Research Laboratory.

Genus *Montacuta* Turton, 1822

Montacuta planata (Dall, 1885)

PLATE 20, FIGURES 1, 3-7, 9-11

Unnamed bivalve No. 7, Möller, 1842a, p. 24.

Montacuta elvata Mörch, in Jones, 1875, p. 131 (not of Stimpson, 1851).

Montacuta molleri "Holboll" Mörch, in Jones, 1875, p. 131; in Rink, 1877, p. 441 (name only).

Montacuta ferruginosa var. *gronlandica* Mörch, in Rink, 1857, p. 91 [specimen No. 164] (fide Posselt, 1898, p. 75).

Tellimya planata Dall, in Krause, 1885a, vol. 51, p. 34, pl. 3, figs. 6a-d.

Montacuta molleri Posselt, 1898, vol. 23, p. 74.

Mysella planata Dall, 1899, p. 892, pl. 88, fig. 12.

Mysella molleri Dall, 1899, p. 891, pl. 88, fig. 14.

Rochefortia planata Dall, 1921, p. 37.—Oldroyd, 1924, p. 132.

Eight fairly typical living specimens were dredged: 1 (1.9 mm. long by 1.4 mm. high) from 216 feet; 1 (4.4 by 3.3 mm.) from 328 feet; 1 (2.8 by 2.1 mm.) from 341 feet; 1 (3.3 by 2.4 mm.) from 477 feet; and 4 (1.5 by 1.1 mm., 1.8 by 1.4 mm., 2.2 by 1.6 mm., and 2.8 by 2 mm.) from 741 feet.

Four other living specimens, possibly variants of *M. planata*, were dredged: 3 (6.9 by 4.9, 3.1 by 2.4, and 1.5 by 1.3 mm.) from 477 feet and 1 (1.8 by 1.4 mm.) from 741 feet.

OTHER MATERIAL EXAMINED: The type (1 right valve) and cotypes (USNM 159303) of Dall's *Tellimya planata* from Plover Bay, Siberia (see pl. 20, fig. 3); his figured type (USNM 159310) from the Shumagins (pl. 20, fig. 6); and approximately 30 specimens (including dead shells) from localities ranging from Icy Cape (1 specimen), Nunivak

Island, the Aleutians, and the Shumagins. Dall's type lot (USNM 333648) of *Mysella molleri* from Greenland (see pl. 20, fig. 5). Six specimens from Frederikshaab, western Greenland, sent to me by Dr. Thorson (see pl. 20, fig. 1).

DISCUSSION: The shells have a thick, light brown periostracum. All of them are eroded at the umbos (pl. 20, fig. 9). In the largest shell from Point Barrow (from 328 feet) the erosion extends to the ventral one-fourth of the shell, and at the umbos the erosion is so deep that the tooth is visible from the exterior. This shell is larger and more inflated than the others and the teeth are particularly large and coarse. This specimen contained 24 embryos, with shells about 0.65 mm. in length (see pl. 20, fig. 4).

In the 4 atypical specimens mentioned above, the umbos (which are eroded as in typical *M. planata*) are somewhat more centrally located than in typical specimens, the shell appears thinner, and the periostracum seems to be somewhat more wrinkled. In the largest specimen (pl. 20, fig. 7), the only one opened, the hinge teeth are exceptionally small, being about half as large as those of a typical *M. planata* of comparable size, a character that is compatible with the thinner and less chalky nature of the shell.

In the synonymy above, the first four references and the sixth are taken from Dall (1899, p. 891). He states "Posselt furnishes the link which connects the name with Mörch's unnamed diagnosis. The identification can take date only from 1898 as all the previous references were absolutely without any means of identification." I have not had access to all of the literature cited in these references but if Dall's statement is correct, *Montacuta molleri* Mörch must fall as a synonym of *Montacuta planata* (Dall), for in 1885 Dall described this species as *Tellimya planata* from some shells from Plover Bay (pl. 20, fig. 3). Although Posselt gave validity to *Montacuta molleri* by his description in 1898, Dall's description of *Tellimya planata* was earlier.

Dall's original description of *Tellimya planata* (1885a) was accompanied by a poor outline drawing, apparently by Krause, for Dall later apologized for the illustration and pictured a specimen he had selected for the figured type of *Mysella planata* (Dall) (1899, pl. 88, fig. 12). The shell he selected is a thin-shelled, small-toothed form in which the umbos are not quite so close to the posterior end (pl. 20, fig. 6) as in his type of *M. planata*; it resembles the largest of the shells mentioned above from 477 feet from Point Barrow (pl. 20, fig. 7). In the same paper Dall assigned some shells from Greenland (pl. 20, fig. 5) to *Mysella molleri* (Mörch) and selected for the figured type a typical *Montacuta planata*.¹³

¹³ Dall's *Rochefortia beringensis* and *R. grebnitzski* belong to the genus *Montacuta*. The southern range given for *Mysella tumida* Dall is incorrect—the specimens from off Santa Rosa Island and Monterey Bay belong to two other genera; hence the southern limit for *M. tumida* is Puget Sound.

DISTRIBUTION: Eastern Siberia and Point Barrow, Alaska, to the Shumagin Islands; Greenland, Spitzbergen, and Novaya Zemlya. Point Barrow is a new locality.

Suborder CYCLODONTA

Family CARDIIDAE

Genus *Clinocardium* Keen, 1936

Clinocardium ciliatum (Fabricius, 1780)

PLATE 26, FIGURE 4

Cardium ciliatum Fabricius, 1780, p. 410.—G. Sars, 1878, p. 46, pl. 5, figs. 4a-b.—Oldroyd, 1924, p. 142, pl. 19, figs. 8, 8a.

Clinocardium ciliatum Morris, 1947, p. 41, pl. 17, fig. 3; 1951, p. 63, pl. 17, fig. 3; 1952, p. 39, pl. 9, fig. 9.—Kira, 1954, p. 111, pl. 55, fig. 2.

Four living specimens ranging from 45 mm. long by 43 mm. high to 62 by 60 mm. were taken from 110 feet (Sept. 8, 1948), 152 feet, 453, and 522 feet. A shell 21 by 20 mm. was taken at Eluitkak Pass (Aug. 10, 1948), another 25.5 by 24.5 mm. at 110 feet, and 1 valve 28 by 27 mm. at 295 feet.

OTHER MATERIAL EXAMINED: Many specimens from localities ranging from Icy Cape (1 valve), Cape Prince of Wales (1 valve), and Bering Strait to the Pribilofs, the Aleutians, and Sitka Harbor; also from Davis Strait, Greenland; Labrador, Newfoundland, Maine, and Massachusetts; and from Iceland.

DISTRIBUTION: From Point Barrow to Puget Sound and Japan; in the Atlantic area from the Arctic Ocean to Cape Cod and northern Norway. This is the first record of living specimens from north of Bering Strait.

Genus *Serripes* Gould, 1841

Serripes grønlandicus (Bruguère, 1789)

PLATE 26, FIGURE 5

Cardium grønlandicum Bruguère, 1789, p. 222.

Serripes grønlandicus Gould, 1870, p. 145, fig. 454.

Serripes groenlandicus Clench and Smith, 1944, p. 28, pl. 13, figs. 5-7.—Abbott, 1954, p. 401, pl. 32d.

A total of 31 living specimens and 7 shells was collected from 19 stations (never more than 3 at any one station) and 3 living and 3 dead specimens were washed ashore in August and September 1949. Three of the living specimens and 3 shells came from Eluitkak Pass, 1 from 328 feet, and 1 from 420 feet, the remainder coming from depths of 50 to 184 feet. The majority of these specimens are over 20 mm. in length; the largest (from 328 feet) is 60 by 51 by 28 mm.

Young specimens were taken as follows: 1 (slightly over 3 mm. long) at 152 feet on Oct. 14, 1949; 1 (9 mm.) at 138 feet on Aug. 1, 1950; 1 (9 mm.) at 151 feet on Aug. 5, 1950; 2 (5.5 mm. and 11 mm.) at 175 feet on Oct. 14, 1949; 1 (15 mm.) at 184 feet on Aug. 30, 1949; 3 (13, 16.5, and 19 mm.) at 125 feet on Sept. 9, 1948; and 1 (19 mm.) at 120 feet on Aug. 8, 1949.

OTHER MATERIAL EXAMINED: Numerous specimens from localities ranging from the mouth of the Mackenzie River to Point Barrow and south and east to the southern coast of Washington; several from the Atlantic area.

DISCUSSION: The shells of this species, at least those from Point Barrow, are very brittle and often crack while in the trays, pieces even breaking off entirely. They vary in color from a rosy gray to an olive tan, even on the same shell; some show zigzag markings of rose, others are nearly a solid color—grayish tan, for instance. The lines of annual growth are usually darker in color than the remainder of the shell (pl. 26, fig. 5). The siphons, foot, and mantle edge are reddish brown on a cream background.

Three shells from Point Barrow, measuring 47, 53, and 54 mm., show growth ridges indicating that they are at least 6 years old. What may be called secondary growth ridges, indicating a temporary cessation of growth, are about as prominent as the yearly growth lines, making the determination of age difficult. One shell 54 mm. in length appears to be 9 or 10 years old, but may be only five.

DISTRIBUTION: Throughout the Arctic; from the Pacific area south to Puget Sound, and Hakodate, Japan; from the Atlantic area south to Cape Cod; and from Finnmarken and Iceland.

Suborder TELEODONTA

Family TAPETIDAE

Genus *Liocyma* Dall, 1870

Liocyma fluctuosa (Gould, 1841)

PLATE 23, FIGURES 1-8

Venus fluctuosa Gould, 1841, p. 87, fig. 50.

Tapes fluctuosa Gould, 1870, p. 136, fig. 447.

Liocyma beekii Dall, 1870b, p. 257; 1871, p. 145, pl. 14, fig. 7.

Liocyma scammoni Dall, 1871, p. 145, pl. 14, fig. 9.

Liocyma viridis Dall, 1871, p. 146, pl. 14, fig. 8.—Oldroyd, 1924, p. 159, pl. 1, fig. 3.

Liocyma aniwana Dall, 1907, p. 172; 1925, p. 18, pl. 28, figs. 4, 6; pl. 29, figs. 1, 2.

Liocyma scheffcri Bartsch and Rehder, 1939, p. 111, pl. 8, figs. 1, 1 b.

Liocyma fluctuosa Morris, 1951, p. 71, pl. 43, fig. 2.

A total of 42 specimens, including 3 or 4 drilled shells, was collected. Six were washed ashore: 1 (12.2 mm. long) on Sept. 12 and

5 (from 8.5 to 13 mm.) on Sept. 22, 1949. Three were taken in a plankton net when it touched bottom: 1 (4 mm.) on Nov. 1, 1949, and 2 (2.5 and 3.8 mm.) on July 13, 1950. Eleven (from 3.1 to 5.5 mm. long) were dredged at a depth of 10 feet on Oct. 11, 1949; 1 (17.4 mm.) at 72 feet; 2 (18.9 and 24.6 mm.) at 80 feet on Aug. 21, 1948; 1 (9.5 mm.) at 132 feet; 1 (20.3 mm.) at 175 feet; 6 (from 16 to 27 mm.) at 246 feet; 2 (17.6 and 20.6 mm.) at 295 feet; 3 (5.6, 15.1, and 15.2 mm.) at 341 feet; 3 (2.5, 12.2, and 15.3 mm.) at 453 feet; 1 (19 mm.) at 522 feet; and 2 (11 and 13.7 mm.) at 741 feet.

In all of the Point Barrow specimens the umbos are eroded—even the very smallest ones are somewhat eroded. Two of the specimens that washed ashore on September 22 contained very large eggs and another contained eggs in earlier stages of development.

OTHER MATERIAL EXAMINED.—The types of *L. viridis*, *L. becki*, *L. aniwana*, *L. scammoni*, and *L. schefferi* (there is only one specimen of *L. schefferi*) and all other specimens of these species as well as all of the specimens of *L. fluctuosa* in the U. S. National Museum.

DISCUSSION: After examining these specimens and taking many measurements, I am of the opinion that the above species are but variants of *L. fluctuosa*. Arctic shells are highly variable, and the variations exhibited by these "species" are no greater than, perhaps not so great as, those found in *Astarte borealis* and *A. montagui*, for instance. Young specimens of *Liocyma fluctuosa* tend to be more trigonal than larger specimens. Specimens of *L. viridis* are no more produced and arched along the ventral margin than many specimens of *L. fluctuosa*; in some specimens of *L. viridis* the sinus is rounded and in others it may be sharply angulated, and these same variations may be found in the sinus of *L. fluctuosa*; muscular scars are no smaller than those in comparable specimens of *L. fluctuosa*. *L. schefferi* is a tumid specimen in which the concentric sculpture is faint except at rather evenly spaced intervals, where flattened waves occur. Similar sculpture may be found in specimens of *L. viridis*, *L. becki*, and *L. fluctuosa* (pl. 23, fig. 8). Still other specimens of these last three forms may have closely spaced concentric undulations in various combinations with the widely spaced type. Young specimens of *L. aniwana* have practically the same proportions as young *L. fluctuosa*, but the specimen that was selected as the type is especially thin and shallow.

With the exception of those of *L. becki*, the percentages given in table 5 fall within the normal limits of variation. It is possible that the specimen selected was an extreme variant rather than typical.

TABLE 5. — *Ratios of measurements in several "species" of Liocyma*

"Species"	Length (in mm.)	Height: Length	Breadth: Height	Breadth: Length
<i>fluctuosa</i> (from Gulf of St. Lawrence)				
tumid specimen	Under 15	80. 1%	60. 7%	48. 6%
tumid specimen	Under 15	81. 3	58. 9	47. 5
tumid specimen	Under 15	83. 0	53. 0	44. 0
<i>scammoni</i> (from British Columbia)				
type	Over 20	80. 3	61. 4	49. 2
cotype	Over 20	78. 9	62. 3	49. 2
specimen	Over 15	82. 1	57. 8	46. 3
specimen	Over 15	75. 9	58. 8	44. 6
<i>schefferi</i> (from Chuginadak Island)				
type	Under 15	80. 8	56. 0	45. 2
<i>aniwana</i> (from Sakhalin)				
type	Over 20	72. 9	53. 9	39. 8
specimen	Over 15	78. 3	56. 7	44. 1
specimen	Under 15	80. 2	63. 9	52. 3
<i>viridis</i> (from "Arctic Ocean")				
type	Over 20	67. 4	54. 4	36. 3
specimen	Over 20	76. 3	49. 7	37. 9
specimen	Under 15	76. 6	49. 5	40. 0
specimen	Under 15	77. 7	50. 0	38. 8
<i>becki</i> (from Plover Bay)				
type	Under 15	96. 4	73. 7	71. 1
sp. (from Point Barrow)				
specimen	Over 20	74. 4	63. 4	47. 2
specimen	Over 20	75. 0	62. 1	47. 2
specimen	Over 20	77. 4	60. 7	47. 0
specimen	Over 20	79. 2	63. 3	50. 2
specimen	Over 15	77. 4	53. 4	47. 3
specimen	Under 15	78. 0	46. 6	36. 4
specimen	Under 15	80. 1	47. 9	39. 2

Also, in a number of species, specimens from Plover Bay have characteristics developed to a degree not shown by specimens of the same species from other localities. Most specimens of *L. becki* do not show such great height in proportion to the length.

One lot of 7 specimens of *Liocyma* (from Point Barrow) of various sizes and with concentric sculpture varying from closely set to widely spaced, including two with a combination of the two types of sculpture, were sent to the museum in Copenhagen for comparison with the European *Liocyma*. W. K. Ockelmann identified all the specimens as *L. fluctuosa*.

In view of the above findings, it is obvious that a thorough study of the genus is indicated to determine if these various forms can actually be separated into species or if they are merely variants of one species.

DISTRIBUTION: The Arctic Ocean southward to northern Japan and eastward to Kodiak Island and Port Etches (long. 147° W.), Alaska; in the Atlantic area southward to Nova Scotia and Massachusetts ?; the White Sea, and Iceland. *L. fluctuosa* is a new name in the Pacific-Arctic fauna.

Family TELLINIDAE

Genus *Tellina* Lamarck, 1799*Tellina lutea* Wood, 1823 (ex Gray, MS.)

Tellina lutea Wood, 1828, pl. 1, *Tellina*, fig. 3.—Dall, 1900, p. 322, pl. 4, figs. 15, 16.—Oldroyd, 1924, p. 169, pl. 1, fig. 9.—Abbott, 1954, p. 425, figs. 87c,d. *Tellina lutea venulosa* Schrenck, 1861, p. 412.—Oldroyd, 1924, p. 169, pl. 1, fig. 11. *Peronidia venulosa* Kira, 1954, p. 120, pl. 60, fig. 29.

Neither living nor dead specimens of this species were dredged in the area investigated off Point Barrow base, but about 200 yards inland from the shore, at depths of from 8 to 15 feet, where a tunnel was being excavated for the storage of food, shells and valves were abundant. Shells up to 74 mm. long were found.

OTHER MATERIAL EXAMINED: (Including *T. lutea venulosa*.) Numerous specimens from localities ranging from Bering Island, the Pribilofs, and the Aleutians to Cook Inlet; also Sakhalin Island, northern Japan.

DISCUSSION: In some of these specimens the posterior end is almost straight and in others it is as curved as that of *Macoma nasula*. In some there are lamellose extensions at the lines of growth. There is great variation in the weight of shells of the same size. *T. lutea venulosa* is said to be "much narrower and more pointed at the posterior end," but examination of many specimens shows that there are all combinations of characters and all intergrades. The "venulose" characteristic is found only in specimens in which the periostracum has been injured, allowing chemical action and the deposition of foreign materials in checks in the shell.

DISTRIBUTION: Point Barrow, Alaska, the Aleutians and Cook Inlet, also northern Japan, and Bering Island east of Kamchatka.

Genus *Macoma*¹⁴ Leach, 1819*Macoma incongrua* (Martens, 1865)

Tellina incongrua Martens, 1865, p. 430.

Macoma incongrua Oldroyd, 1924, p. 170, pl. 42, fig. 10.

A single specimen, measuring 25 by 20 by 8.5 mm., washed ashore on Sept. 22, 1949.

OTHER MATERIAL EXAMINED: Several specimens from Alaska.

DISTRIBUTION: From Point Barrow south to San Diego, Calif., and also from Japan. Point Barrow is a new locality.

¹⁴ Since no specimens of *Macoma planiuscula* Grant and Gale were found at Point Barrow, the species does not come within the scope of this paper. However, while examining specimens of the genus *Macoma* in the U. S. National Museum, I observed some from England labeled *Macoma praetenuis* Woodward that appeared to be identical with *M. planiuscula*. Time did not permit a thorough investigation, but it is a matter that should be studied further.

Macoma calcarea (Gmelin, 1792)

PLATE 24, FIGURES 5-7; PLATE 26, FIGURES 6-9

Tellina calcarea Gmelin, 1792, vol. 7, p. 3236.*Macoma calcarea* Oldroyd, 1924, p. 173, pl. 42, fig. 5.—Abbott, 1954, p. 430, fig. 88f (outline drawing).

This was one of the three most abundant species of bivalves collected in the area investigated at Point Barrow, and over 200 specimens were taken. It was found at all stations having a muddy bottom, including the stations at 477 feet (2 small, 8.5 mm. and 10.5 mm. long) and 741 feet (2 small, about 8 mm. and 11 mm.; 1 large, the next to the largest specimen taken, 41.3 by 27.5 by 12.3 mm.). A few small specimens were taken from bottoms characterized by rocks and stones: 1 (7.5 mm. long) from 295 feet; 1 (5 mm.) from 341 feet; and 1 (9 mm.) from 453 feet. The others came from stations with originally muddy bottoms or stations where mud had been deposited in the autumn of 1949. The majority of specimens range between 13.5 and 37 mm. in length; the largest (47.5 mm. long by 26 mm. high) came from 141 feet.

In addition to those mentioned above, small specimens were collected as follows: 3 (between 8.5 and 11 mm.) from 72 feet on July 21, 1950; 1 (about 6 mm.) from 120 feet; 1 (about 8 mm.) from 130 feet; 25 (between 8.5 and 17.5 mm.) from 132 feet; 2 (about 7 mm.) and 8 (between 13.5 and 17 mm.) from 148 feet; 1 (about 2.5 mm.) from 151 feet; 1 (about 5 mm.) from 162 feet; 1 (about 7 mm.) from 185 feet; 9 (between 8.5 and 20 mm.) from 204 feet; and 8 (between 9 and 21 mm.) from 213 feet. The haul from 132 feet also yielded 13 specimens from 19.5 to 39.5 mm. long and the one from 148 feet yielded 14 specimens from 14.5 to 37 mm. long.

At Point Barrow, *M. calcarea* lives in extremely sticky mud, making it necessary to wash each specimen separately. Dragging the loaded dredge in the wake of the boat was entirely ineffectual—the mud had to be worked over by hand.

OTHER MATERIAL EXAMINED: About 40 specimens from localities ranging from Point Barrow to Plover Bay, Kamchatka, Nunivak Island, the Aleutians, and off the coast of Washington (12 specimens), off the coast of Oregon (1 specimen), and Monterey Bay (1 specimen); about 75 specimens from Labrador, Nova Scotia, Newfoundland, and Massachusetts; and over 100 specimens from Spitzbergen, Norway, Scotland, Iceland, and Greenland.

DISCUSSION: These shells vary from light to relatively heavy; some are considerably higher in proportion to the length than others (pl. 24, figs. 5, 6); some are more pointed posteriorly and in some the posterodorsal margin slopes more abruptly than in others; some are more inflated below the hinge than others; and in some the laminate

edge of the anterodorsal margin is higher than in others. Young specimens (pl. 26, figs. 6, 7) usually are higher in proportion to the length than older specimens. Typically, the ventral line of the pallial sinus becomes confluent with the main pallial line about the middle of the length of the sinus (pl. 24, fig. 7); but in some shells only about two-fifths of the ventral line is confluent with the ventral line of the pallial sinus, and in others almost three-fifths of the line is confluent.

Yearly growth lines of the Point Barrow shells of this species are less distinct than in some of the other shells. One shell 18 mm. long is at least $2\frac{1}{2}$ years old, 2 shells 30 mm. and 32 mm. long are at least $4\frac{1}{2}$ years old, and 1 shell 39 mm. long is over 5 years old. Another shell only 28 mm. long and about 17.3 mm. high appears to be between 5 and 6 years old, making approximately the following growth in height each year: first, 4 mm.; second, 3.7 mm.; third, 3.5 mm.; fourth, 3 mm.; and fifth, 3.1 mm.

Although *M. balthica* Linnaeus has been reported from this vicinity, fairly intensive work in the area under investigation yielded no specimens. The writer believes that the young of *M. calcarea* have been mistaken for *M. balthica*. The greater height in proportion to the length in young *M. calcarea* could account for this misidentification.

DISTRIBUTION: Throughout the Arctic and southward to Japan and Monterey Bay in the Pacific and southward to New York and the British Isles and Denmark in the Atlantic.

Macoma moesta (Deshayes, 1854)

PLATE 21, FIGURES 1-3; PLATE 23, FIGURE 10; PLATE 24, FIGURES 1-3

Tellina moesta Deshayes, 1854, p. 361.

Macoma krausei Dall, 1900, p. 322, pl. 4, fig. 8.

Tellina (Macoma) moesta Jensen, 1905, p. 345, figs. 4a-c.

Macoma oneilli Dall, 1919c, p. 20, pl. 2, fig. 1; 1921, p. 47.—Oldroyd, 1924, p. 173, pl. 40, fig. 7.

Eight adult specimens were dredged: 1 (22.2 mm. long by 14.1 mm. high) at 80 feet on Aug. 21, 1948; 1 (24.4 by 16.7 mm.) at 120 feet on Aug. 9, 1949); 2 (23.8 by 15.6 mm., and 17.2 by 12.1 mm.) at 122 feet; 1 (24.3 by 16.4 mm.) at 132 feet; 1 (23.3 by 16.5 mm. at 134 feet; 1 (22.6 by 16 mm.) at 138 feet; and 1 (20.8 by 14.6 mm.) at 148 feet.

Seven smaller specimens and 1 valve that may be the young of this species were collected: 1 at 50 feet on July 26, 1948; 1 and 1 valve at 80 feet on Aug. 21, 1948; 4 that washed ashore on Sept. 12, 1949, and 1 on Sept. 19, 1949. These shells range between 10.6 and 16.6 mm. in length.

OTHER MATERIAL EXAMINED: Dall's cotype of *M. oneilli* from Dolphin and Union Straits, Northwest Territories; 3 from Winter Harbor,

Melville Island; 1 small specimen from Point Barrow; 1 from Icy Cape and 1 from between Icy Cape and Cape Lisburne; and 6 or 7 from Plover Bay. Also Dall's figured type and type lot of *M. krausei* from off Icy Cape, Alaska, 7-15 fathoms. Over 50 specimens labeled *M. moesta* from localities ranging from Icy Cape to Bering Strait to the Pribilofs, the Aleutians, and the Shumagins; also from Plover Bay and Kamchatka.

DISCUSSION: Jensen (1905) places *M. krausei* Dall in the synonymy of *M. moesta*. Dall's type lot of *M. krausei* (pl. 21, figs. 1-3) consists of 4 small shells and 1 valve, ranging in length from 6.8 to 12.7 mm., and 1 dead shell (the figured type, pl. 21, fig. 1) 23.1 mm. in length. The small shells of *M. krausei* are very similar to the 7 small shells and 1 valve from Point Barrow, but the shell of the figured type (pl. 21, fig. 1) is more pointed and more extended posteriorly and less extended anteriorly, so that the umbos are not so near the posterior end as in the smaller shells and in the typical adults of *M. moesta*.

Although Dall described typical adult *M. moesta* as *M. oneilli*, the 50 or more smaller specimens mentioned above were identified as *M. moesta*. That Dall himself may have entertained some doubt as to the specific validity of *M. krausei* is suggested by the fact that he (Dall, 1921, p. 47) gives the following reference for *M. moesta* Deshayes: "Proc. U. S. Nat. Mus., vol. 23, pl. 4, fig. 8." This reference is for the original description of *M. krausei* and in this paper Dall (1921) does not even mention *M. krausei*.

The 7 small specimens (see pl. 24, figs. 2, 3) from Point Barrow correspond fully with the 50 smaller specimens labeled *M. moesta*. Some of the latter shells have a thin, transparent periostracum, others a yellowish olive-green; those from Point Barrow have the thin transparent periostracum. Those from Kyska Harbor and Amchitka Island are somewhat more inflated than usual; others from these two localities, as well as a few from the Shumagins, are somewhat higher in proportion to the length than others. Several small specimens of *M. moesta* from Greenland (sent to me by Dr. Thorson) have a yellowish olive-green periostracum and are high in proportion to the length (see table 6).

The 8 adult specimens from Point Barrow correspond fully with Dall's *M. oneilli* and they also correspond fully with Deshayes' description of *M. moesta*. W. K. Oeckelmann of Copenhagen, who has compared them with specimens of *M. moesta* from Greenland, states that they are unquestionably *M. moesta*. Except on the anterior end, these shells have a brownish concretion along the margins (pl. 24, fig. 1), and the periostracum extends onto the interior surface for as much as 2 mm. (pl. 23, fig. 10).

TABLE 6.—*Proportionate lengths and heights of Macoma moesta and M. "krausei"*
(KEY: H, height at umbo; H', height at highest point of shell; L, length. Measurements in millimeters, ratios in percent)

Species	H	H'	L	H:L	H':L
<i>M. moesta</i> from Point Barrow specimen	10.2 15.6	10.3 16.8	15.3 23.8	66.6 65.5	67.3 70.6
<i>M. moesta</i> from Greenland specimen	8.2 11.9 12.7	8.4 12.0 13.0	11.4 16.8 18.1	71.9 70.2 70.8	73.7 71.8 71.4
<i>M. "krausei"</i> figured type from Icy Cape small specimen from Point Barrow	14.0 7.8	14.5 7.9	23.1 12.7	60.6 61.3	62.7 62.2

The longer length of *M. krausei* to its height in comparison with that of *M. moesta* is demonstrated in table 6. However, it is highly probable that Dall's specimens of *M. krausei* are simply extreme variants and that the greater length of these specimens comes within the normal limits of variation of *M. moesta*.

DISTRIBUTION: Point Barrow, Alaska, Nunivak Island, the Aleutians, coasts of Washington, Oregon, and Monterey Bay, Calif., also Kamchatka; W. K. Oekelmann (personal communication) gives the Atlantic range as eastern and western Greenland, Baffin Land, Spitzbergen, Novaya Zemlya, and the Kara Sea; and Jensen (1905) adds the Tschuktscher Peninsula and the Siberian-Arctic Sea.

Suborder ASTHENODONTA

Family MYACIDAE

Genus *Mya* Linnaeus, 1758

Mya truncata Linnaeus, 1758

And var. *uddevallensis* Forbes

PLATE 25, FIGURES 1-3

Mya truncata Linnaeus, 1758, ed. 10, p. 670.—Oldroyd, 1924, p. 197, pl. 10, fig. 4.—Foster, 1946, p. 30, pls. 17-19.—Morris, 1951, p. 89, pl. 22, fig. 8; 1952, p. 58, pl. 16, fig. 5.—Abbott, 1954, p. 455, pl. 32v.

Mya truncata var. *uddevallensis* Forbes, 1846, p. 407.—Grant and Gale, 1931, p. 415.

Mya truncata var. *abbreviata* Jeffreys, 1865b, p. 67.

Approximately 25 specimens were collected: 12 specimens, usually with the animal intact and sometimes still living, and 4 valves washed ashore between Aug. 21 and Sept. 28, 1949; 2 specimens (55 and 55.3 mm.) and 1 valve (57 mm.) were taken at Eluitkak Pass; 1 juvenile (probably of true *M. truncata*) was collected at 10 feet on Oct. 14, 1949; 4 (from 6 to 8.5 mm.) came from 477 feet; 1 (19.5 mm.) came

from 217 feet; and 4 others (from 6 to 10.5 mm.) came from 122, 132, 184, and 341 feet. Eight of the specimens that washed ashore range between 39 and 55 mm. in length; 1 is 11 mm., and 2 are 18.5 mm.

One empty shell (about 57.5 by 43.7 by 29 mm.) and 1 valve of about the same size, taken from Eluitkak Pass on Aug. 10, 1948, belong to the var. *uddevallensis*.

OTHER MATERIAL EXAMINED: Approximately 30 specimens from Norway, the Shetlands, Greenland, Cumberland Gulf, and Maine—about 4 of which belong to the var. *uddevallensis*; also specimens from Puget Sound.

DISCUSSION: In typical *M. truncata* the posterior end (measured from the vertical from the beaks) is nearly as long as the anterior end, and the posterior end is obliquely truncate in such a manner that the ventral margin extends farther posteriorly than the dorsal (pl. 25, fig. 1). In typical var. *uddevallensis* the posterior end is so shortened that it is not much more than one-half as long as the anterior, and it is truncate in such a manner that the posterior dorsal margin is almost twice as long as the posterior ventral margin (pl. 25, fig. 3). Typical var. *uddevallensis* is much higher in proportion to the length than typical *M. truncata*, and the pallial sinus is much shorter in the former. However, there are all types of intergradations between these two extremes: In some specimens the posterior end is squarely truncate and in others even somewhat rounding-truncate; there are all degrees of relationship between the proportions of the length of the anterior and posterior ends; and the pallial sinus varies from extremely shallow to so deep that it may project anteriorly to or beyond a vertical line from the beaks. The shorter, *uddevallensis*, form tends to be more inflated in the anterior regions than the longer *M. truncata*.

The var. *uddevallensis* is sometimes listed as a separate species, and although typical var. *uddevallensis* differs markedly from typical *M. truncata*, complete series of intergradations leave no doubt that the former is only a variety of the latter. Foster (1946) considers *uddevallensis* merely an extreme variant of *M. truncata*. The *M. truncata* from Point Barrow (pl. 25, fig. 2) is intermediate between typical *M. truncata* and typical var. *uddevallensis*.

There has been considerable discussion regarding the differences between *M. truncata* and *M. arenaria*, some workers even going so far as to suggest that *M. truncata* is merely a variety of *M. arenaria*, but no one who has seen the living animals would fail to distinguish between adults of these two species. In *M. truncata* a thick, tough, loose, and highly wrinkled sheath of periostracum extends onto the siphons (see Abbott, 1954, pl. 32v) and covers them to the tip; in *M. arenaria* this sheath is very thin and closely adherent and does not extend very far. The pallial sinus of *M. arenaria* is narrower

than that of *M. truncata* and always is sufficiently long that a vertical line from the beaks cuts across it, whereas in *M. truncata* the sinus may or may not extend to such a vertical line. The ventral scar of the pallial sinus of *M. arenaria* is above and separate from the main pallial scar (pl. 25, fig. 5), whereas in *M. truncata* these scars are either contiguous or confluent throughout most of the length of the sinus (pl. 25, figs. 1-3).

DISTRIBUTION: *M. truncata* extends from Point Barrow south and east to Puget Sound; on the east coast from Greenland to Massachusetts (Johnson, 1934); Norway, Iceland, the Shetlands, and England. The var. *uddevallensis* has been collected at Point Barrow (G. E. MacGinitie, 1955), at Afognak and Raspberry Islands (near Kodiak Island), and in Sweden (W. J. Eyerdam) (see Burch, 1945, No. 44, p. 25); in Norway and Iceland and southward to the Bay of Biscay (see Madsen, 1949, p. 77). Point Barrow is a new locality for var. *uddevallensis*.

Mya pseudoarenaria Schlesch, 1931

PLATE 19, FIGURE 7; PLATE 25, FIGURE 4

Mya intermedia Dall, 1898, p. 857 (in part).

Mya truncata forma *ovata* Jensen, 1901,¹⁵ pp. 139, 144, figs. 3-5, 6a-c (not *M. ovata* Donovan, 1802).

Mya pseudoarenaria Schlesch, 1931, p. 136, pl. 13, figs. 10-12.—Soot-Ryen, 1951, p. 3.

About 16 specimens were collected: Between Aug. 21 and Sept. 24, 1949, 4 specimens (from 23 to 67 mm. long) washed ashore; on Aug. 23, 1950, 1 specimen (31 mm.) washed ashore; 3 specimens and 5 valves (from 43 to 66 mm.) were dredged at Eluitkak Pass on Aug. 6, 10, 1948; 3 specimens (about 11 mm.) were dredged at 10 feet on Oct. 11, 1949; 1 (about 12 mm.) at 120 feet on Sept. 15, 1948; 1 shell (16 mm.) at 120 feet on Aug. 8, 1949; and 2 shells (13 and 14 mm.) and 1 living specimen (14 mm.) at 162 feet on Feb. 18, 1950. Specimens that washed ashore were often still alive.

OTHER MATERIAL EXAMINED: Numerous specimens of *M. "intermedia"* from the Probilofs, the Aleutians, and Kamchatka; specimens of *M. truncata* forma *ovata* from Greenland; several specimens of *M. japonica* Jay from Japan and Puget Sound; also specimens of *M. arenaria* from the Atlantic and Pacific coasts.

DISCUSSION: It is now generally conceded that all recent records of living *M. arenaria* Linnaeus (1758, p. 670) in the Arctic are of some other species. Dall (1898), realizing that a *Mya* from Alaska belonged neither to *M. truncata* nor to *M. arenaria*, described it as a new species under the name *intermedia*—a name that was later found to be pre-

¹⁵ The date for this form is usually given as 1900. The volume was for the year 1900, but it was published in 1901.

occupied. Jensen (1901) also recognized that the northern form of *Mya* commonly assigned to *M. arenaria* is not this species, and he gave to this northern European form the name of *M. truncata* forma *ovata*. Madsen (1949), who found no *M. arenaria* in an extensive collection from Iceland, also uses the name *ovata* as a form of *M. truncata*, but Foster (1946) and Soot-Ryen (1951) consider *M. truncata* forma *ovata* Jensen a synonym of *M. pseudoarenaria* Schlesch.

Schlesch (1931) considered this northern form sufficiently distinct to warrant a specific name, as it probably does. Although he does not mention *M. japonica* Jay (1856),¹⁶ he does refer to *M. intermedia* Dall, stating that he considers the latter distinct from *M. pseudoarenaria*. He states (translated from German): "It is astonishing, however, that *M. intermedia* Dall, also with *M. arenaria*, extends to Monterey in California. It shows therein greater agreement with *M. arenaria* than with *M. truncata*, which only extends to Puget Sound. While *M. pseudoarenaria* goes heart in hand with *M. truncata*, *M. intermedia* obviously stands closer to *M. arenaria*, a phenomenon of convergence." Although *M. japonica* Jay (=Dall's *M. intermedia*) is undoubtedly closely related to *M. arenaria*, and *M. pseudoarenaria* is more closely related to *M. truncata*, Schlesch's idea of convergence as related to range was based on Dall's misidentification of several small shells from the vicinity of Monterey. The specimen from Monterey Bay (in the U. S. National Museum) is not even a *Mya*; the 3 small specimens (about one-quarter inch long) from San Francisco Bay are undoubtedly the young of *M. arenaria*; and the 2 specimens (also measuring about one-quarter inch) from 13 fathoms off Punta Año Nuevo, Calif., are almost certainly the young of *M. arenaria*. But a specimen (about one-half inch long) from the Gulf of Georgia, British Columbia, and another specimen (about 1¼ inches long) from Bellingham, Wash., appear to be the young of *M. pseudoarenaria*.

Dall's lectotype of *M. intermedia* is shown in plate 19, figure 6. Since the name *intermedia* is unavailable, the figured shell can undoubtedly be assigned to *M. japonica* Jay. Jay (1856, p. 292) states that *M. japonica* "is similar to *M. arenaria*, but differs in the pallial impressions, which are much more profound, the tooth more thickened, a deep notch on its posterior, and an elevation on the anterior side, and the whole shell more ponderous and incrassated." In the specimen figured by Jay (1856, pl. 1, fig. 10) the pallial sinus is not so deep and the anterior end is not so long and high as in Dall's lectotype, in which the sinus is unusually large. In many specimens of *M. japonica* the pallial sinus is no deeper than in most *M. arenaria* (cf. pl. 19, fig.

¹⁶ The date for *Mya japonica* Jay is usually given as 1857, but M. C. Perry's account, containing Jay's report on the shells, was published in 1856. Two editions of Perry's narrative, a quarto and an octavo, were published, both in 1856.

8, and pl. 25, fig. 5). The differences in tooth characteristics seem to be more constant.

Another specimen that Dall placed under *M. intermedia* is shown in plate 19, figure 7. In shape it is similar to *M. arenaria* but the pallial sinus and hinge are more like those of *M. truncata*. This shell is no doubt a *Mya pseudoarenaria*, which apparently never attains the large size reached by *M. japonica*. Dr. Rehder, who kindly checked for me the specimens in the U. S. National Museum labeled *M. intermedia*, found that none of the large specimens has a pallial sinus like that shown (pl. 19, fig. 7). It becomes obvious that Dall placed two different species under *M. intermedia*.

Although I have not seen the type of *M. pseudoarenaria*, nor any specimens identified as belonging to this species, it is almost certain that the shells from Point Barrow belong to it. The fossil specimens pictured by Schlesch do not show the pallial sinus clearly but he considers his species synonymous with *M. truncata* forma *ovata* Jensen, and specimens of the latter from Greenland, lent me by Dr. Thorson, are similar to the Point Barrow specimens (see pl. 25, fig. 4) and to the shell shown in plate 19, figure 7. Schlesch's description states (translation): "The shell is oval with more or less rounded posterior end and shows external fine and radiating striae. Superficially it looks much like *M. arenaria* but the form of the hinge plate shows that it stands next to *M. truncata*."

Living specimens from Point Barrow show another similarity to *M. arenaria* in that the sheath that extends onto the siphons is more like that of *M. arenaria*, for it is not nearly so tough, wrinkled, and extensive as in *M. truncata*.

Schlesch (1931) and Jensen (1901) report valves only, but Odhner (1915) reports small living forma *ovata* from the Isfjorden in Spitzbergen. Soot-Ryen (1951) reports seeing small living *M. pseudoarenaria* from Spitzbergen, and in June 1927 and August 1930 he and his companions collected 4 living specimens (ranging in length from 22.5 to 52 mm.) off the coast of Norway between lat. 69°56' N. and lat. 67°8' N.

M. pseudoarenaria is probably more abundant than collecting records indicate. Equipment available at Point Barrow was incapable of penetrating the substratum deeply enough to collect the larger specimens of this species; the largest specimens (see collecting data above) were either washed ashore by storms or were dredged at Eluitkak Pass, where surging waters roll the rocks around and churn up the mud sufficiently to expose some of the deeper mud-dwellers.

DISTRIBUTION: Point Barrow to Bellingham, Wash. (exact Pacific records cannot be given until collections are reexamined with a view to separating *M. japonica* and *M. pseudoarenaria*); Greenland, Iceland, Spitzbergen, coast of Norway.

Family HIATELLIDAE

Genus *Panomya* H. and A. Adams, 1858*Panomya arctica* (Lamarek, 1818)

PLATE 19, FIGURE 1; PLATE 25, FIGURES 6, 8

Glycimeris arctica Lamarek, 1818, vol. 5, p. 458; 1835, vol. 6, p. 70.*Panopaea arctica* Coult., 1841, p. 37, fig. 27; 1870, p. 51, fig. 378.*Panomya turgida* Dall, 1916, p. 416; 1921, p. 54, pl. 2, fig. 1.*Panomya ampla* Oldroyd, 1924, pl. 10, fig. 3.—Morris, 1952, p. 93, pl. 16, fig. 10.—Kira, 1954, p. 123, pl. 61, fig. 17.*Panope* (*Panomya*) *ampla* Grant and Gale, 1931, p. 426, pl. 21, figs. 10a, b.*Panomya arctica* Morris, 1951, p. 91, pl. 43, fig. 16.

Three left valves of this species, ranging from 73 to 78 mm. in length, were dredged at 522 feet.

OTHER MATERIAL EXAMINED: The figured type of *P. arctica*, the figured type of *P. turgida*; specimens of *P. arctica* from Scotland, fossils from Sicily, several specimens from localities ranging from Gaspé Bay, Quebec, to Chesapeake Bay; and 3 specimens of *P. turgida* from Unimak Pass, Unalaska Island, and Port Levasheff.

DISCUSSION: Typically, the anterior end of *P. arctica* (pl. 25, figs. 6, 8) is rounded (instead of being tapered as in *P. ampla*) and the posterior end is obliquely truncate in such a manner that the ventral margin extends farther posteriorly than does the dorsal margin (pl. 19, fig. 1; pl. 25, figs. 6, 8; also see Dall, 1921, pl. 2, fig. 1). The degree of the posterior extension is highly variable, ranging from slight (see Oldroyd, 1924, pl. 10, fig. 3) to marked. In one specimen from Unalaska and one from Port Levasheff the dorsal margin extends as far as the ventral, and in the latter shell the anterior end is somewhat tapered (as in Oldroyd, 1924, pl. 10, fig. 3); but in none of these specimens does the dorsal margin extend beyond the ventral as is the case in *P. ampla*. I could detect no difference between specimens of *P. arctica* and *P. turgida*. There are specimens of *P. arctica* from our east coast that are practically identical with specimens called *P. turgida* from our west coast.

DISTRIBUTION: Point Barrow south and east to Unalaska and the Shumagins; in the Atlantic area from the Arctic Ocean to Chesapeake Bay, the British Isles, and north of Europe. The specimens from Point Barrow extend the range into the Pacific area of the Arctic.

Panomya ampla Dall, 1893

PLATE 25, FIGURE 7

Mya truncata Middendorff, 1851, pl. 25, fig. 13.*Panomya ampla* Dall, 1898, p. 833; 1902, p. 560, pl. 40, figs. 3, 4.

One living specimen was taken at Eluitkak Pass on Aug. 1, 1950, and 1 right valve was dredged at 184 feet. The former shell is 68 mm. long and 44.5 mm. high and the latter is 54 by 40 mm.

OTHER MATERIAL EXAMINED: The figured type from Kyska Harbor, and about 20 other specimens from Nunivak Island, Kodiak Island, Kyska Island, and Unalaska Island.

DISCUSSION: The shells of this species are usually flat but they vary from flat to somewhat inflated. The younger specimens tend to be flatter in proportion than the larger ones. There is also variation in the thickness or heaviness of the shells.

The shell of *P. ampla* is tapered anteriorly and flared posteriorly, and the posterior margin is obliquely truncate in such a manner that the basal line recedes (pl. 25, fig. 7). Oldroyd's (1924) figure 3 of plate 10 is of *P. turgida* (= *P. arctica*) and not of *P. ampla* as stated. This error has been repeated in several subsequent publications; the figures in the following references should read *P. arctica* instead of *P. ampla*: Grant and Gale (1931, pl. 21, figs. 10a, 10b); Morris (1952, pl. 16, fig. 8); and Kira (1954, pl. 61, fig. 17).

DISTRIBUTION: The range of *P. ampla* has been given as the Aleutian region (see localities above) to Puget Sound but the latter locality record has been questioned. In the collections of the U. S. National Museum I saw no specimen of *P. ampla* from Puget Sound. The present range, therefore, is from Point Barrow to Kodiak Island, Alaska. It is new to Point Barrow and to Arctic America.

Genus *Hiatella* Daudin, in Bosc, 1801

Hiatella arctica (Linnaeus, 1767)

PLATE 26, FIGURES 1-3

Saxicava arctica Linnaeus, 1767, ed. 12, p. 1113.—Oldroyd, 1924, p. 208, pl. 9, fig. 6; pl. 51, fig. 4.—Morris, 1947, p. 67, pl. 23, fig. 5; 1951, p. 91, pl. 23, fig. 5; 1952, p. 62, pl. 16, fig. 7.

This was the most abundant bivalve and, with the exception of barnacles, probably the most abundant and the most nearly ubiquitous animal in the area under investigation. Probably no haul except from the strictly muddy bottoms near shore was without representatives of *H. arctica*. Even near shore in the gravel zone, they were found anchored to bits of gravel or old shells. Two specimens (4.5 and 5.5 mm. long) from 184 feet were found growing on the bryozoan *Tricellaria erecta*, and 2 others (5 and 6 mm.) from 341 feet were growing on the bryozoan *Eucratea loricata*. They were found between barnacles, in old clam shells, and among old holdfasts. In addition to 3 or 4 barnacles, an old shell of *Astarte borealis* contained 21 living

H. arctica ranging between 7 and 13.5 mm. in length. Among dozens of specimens (from 3 to 22 mm.) from 477 feet, there were many on which foraminifers were growing and one on which a young *Musculus* was attached to the byssus.

Hauls from Eluitkak Pass on Aug. 6, 1948, from 100 feet on Aug. 21, 1948, and from 125 feet on Sept. 9, 1948, were unusually rich in *Hiatella*. A haul from 150 feet on Aug. 23, 1948, not only was very rich, especially in young specimens, but about half of the mass brought up by the dredge was made up of old dead shells of *Hiatella*. The largest shell (38 mm. long by 16.3 mm. high) came from Eluitkak Pass, and a group of large shells (up to 31 by 14 mm.) came from 10 feet in the gravel zone on Sept. 8, 1949.

Because of their significance as regards growth, selected collecting data are given below: at Eluitkak Pass (Aug. 6, 1948), specimens 2.5 mm. long and up; at 184 feet, specimens 2.5 to 18 mm.; at 120 feet (Sept. 15, 1948), 2.5 mm. and up; at 477 feet, 3 to 22 mm.; at 295 feet, up to 8 mm.; at 80 and 100 feet (Aug. 21, 1948), 4 mm. and up; at 150 feet (Aug. 23, 1948), 4 mm. and up; at 216 feet, 4 to 12 mm.; at 120 feet (Aug. 8, 1949), 4.5 to 14 mm.; at 217 feet, 4 to 9.5 mm.; at 110 feet (Sept. 16, 1949), 5 mm. and up; at 453 feet, 5 to 9 mm.; at 185 feet, 5 to 15.5 mm.; and at 175 feet, 6.5 to 19 mm.

OTHER MATERIAL EXAMINED: Numerous specimens from the Arctic, and from the Atlantic and Pacific.

DISCUSSION: Many of the shells from Point Barrow are well shaped (pl. 26, figs. 1-3) (also Oldroyd, 1924, pl. 9, fig. 6) and not distorted as *H. arctica* often is (Oldroyd, 1924, pl. 51, fig. 4). Young specimens have the characteristic two rows of spines near the anterodorsal margin of each valve, but few retain them very long, their former presence being indicated only by eroded spots along the ridges, and even the latter are sometimes almost obsolete.

A shell of *H. arctica* 30 mm. long from Point Barrow is at least 5 years old.

The age-old problem as to whether or not *H. arctica* and *H. rugosa* constitute one or two species has received additional argument in favor of two species: Jorgensen (1946) found an oval larval form and a triangular larval form of *Hiatella*, the former attributed to *H. rugosa*, the latter to *H. arctica*. Abbott (1954, p. 453), who lists *H. rugosa* (Gmelin) as a synonym of *H. striata* (Fleuriau), states that the eggs of *H. arctica* are red, while those of *H. striata* are pinkish cream.

DISTRIBUTION: As now conceived, *Hiatella arctica* ranges in the Pacific area from the Arctic to Panama, and in the Atlantic from the Arctic to the West Indies.

GENERA AND SPECIES TREATED

(With page numbers of principal entries)

- Adamsi, Thracia, 163
 Admete, 129
 couthouyi, 129
 regina, 131
 albus, Trachydermon, 145
 aleutica, Diplodonta, 172
 Aldisa, 143
 zetlandica, 143
 Alvania, 85
 jan-mayeni, 85
 amocna, Raphitoma, 137
 ampla, Panomya, 190
 angulosum, Buccinum, 109
 Aquilonaria, 83
 turneri, 83
 aretica, Hiattella, 190
 Panomya, 189
 Yoldia, 151
 Astarte, 164
 borealis, 165
 montagui, 167
 avenosooki, Margarites, 77
 Axinopsida, 172
 orbiculata, 172

 Benthoctopus, 149
 hokkaidensis, 149
 beringi, Beringius, 117
 Boreotrophon, 99
 Beringius, 115
 beringi, 117
 stimpsoni, 115
 bicarinata, Trichotropis, 88
 borealis, Astarte, 165
 Trichotropis, 88
 Boreotrophon, 97
 beringi, 99
 clathratus, 98
 pacificus, 100
 truncatus, 101
 Buccinum, 102
 angulosum, 109
 ciliatum, 113
 fringillum, 112
 glaciale, 102
 plectrum, 105
 polare, 108
 tenue, 107
 undatum, 114

 caeca, Lepeta, 73
 calcarea, Macoma, 181
 capponius, Colus, 120
 Cardita, 169
 crassidens, 170
 erebriostata, 169
 cassandra, Odostomia, 141
 castanea, Cingula, 84
 Chlamys, 155
 islandica, 155
 ciliatum, Buccinum, 113
 Clinocardium, 176

 Cingula, 84
 castanea, 84
 Cirroteuthis, 148
 clathratus, Boreotrophon, 98
 clausa, Natica, 90
 Clinocardium, 176
 ciliatum, 176
 Clione, 143
 limacina, 143
 Colus, 119
 capponius, 120
 martensi, 120
 spitzbergensis, 119
 commodus, Piliscus, 93
 compressa, Pseudopythina, 173
 corrugatus, Museulus, 158
 Corypbella, 145
 salmonacea, 145
 costalis, Margarites, 75
 costulata, Molleria, 81
 couthouyi, Admete, 129
 crassidens, Cardita, 170
 erebriostata, Cardita, 169
 Crepidula, 87
 grandis, 87
 Cylichna, 140
 occulta, 140

 deformis, Pyrulofusus, 114
 Dendronotus, 144
 frondosus, 144
 Diaphana, 139
 minuta, 139
 Diplodonta, 172
 aleutica, 172
 discors, Museulus, 159

 edulis, Mytilus, 157
 elegans, "Oenopota," 135
 Epitonium, 83
 greenlandicum, 83

 fabricei, Gonatus, 148
 flexuosa, Thyasira, 171
 fluctuosa, Lioeuma, 177
 frigidus, Margarites, 78
 fringillum, Buccinum, 112
 frondosus, Dendronotus, 144

 glacialis, Onchidiopsis, 92
 Gonatus, 148
 fabricei, 148
 glaciale, Buccinum, 102
 grandis, Crepidula, 87
 greenlandicum, Epitonium, 83
 greenlandica, Onchidiopsis, 93
 grønlandicus, Serripes, 176
 grosvenori, Margaritopsis, 80

 harpa, Oenopota, 134
 harpularia, "Oenopota," 135
 helicina, Spiratella, 142

 heros, Neptunea, 122
 Hiattella, 190
 aretica, 190
 hokkaidensis, Benthoctopus, 149
 hypoborea, Yoldia, 152

 impressa, Nodotoma, 137
 incongrua, Macoma, 180
 islandica, Chlamys, 155

 jan-mayeni, Alvania, 85

 kroyeri, Plieifusus, 126
 Trichotropis, 89

 lanigera, Velutina, 97
 Lepeta, 73
 caeca, 73
 limacina, Clione, 143
 Lioeuma, 177
 fluctuosa, 177
 lutea, Tellina, 180
 Lyonsia, 164
 norvegica, 164

 Macoma, 180
 calcarea, 181
 incongrua, 180
 moesta, 182
 Margarites, 75
 avenosooki, 77
 costalis, 75
 frigidus, 78
 vahl, 79
 Margaritopsis, 79
 grosvenori, 80
 pribilofensis, 79
 martensi, Colus, 120
 middendorffiana, Neptunea, 124
 minuta, Diaphana, 139
 Nuculana, 150
 moesta, Macoma, 182
 Molleria, 81
 costulata, 81
 Montacuta, 174
 planata, 174
 montagui, Astarte
 monteronus, Polinices, 91
 Museulus, 157
 corrugatus, 158
 discors, 159
 niger, 157
 Mya, 184
 pseudorenaria, 186
 truncata, 184
 myalis, Yoldia, 152
 myopsis, Thracia, 162
 Mysella, 173
 sovaliki, 173
 Mytilus, 157
 edulis, 157

- Natica*, 90
clausa, 90
nazanensis, *Oenopota*, 134
Neptunea, 121
heros, 122
middendorffiana, 124
ventricosa, 121
niger, *Musculus*, 157
noachina, *Puncturella*, 74
Nodotoma, 137
impressa, 137
norvegica, *Lyonsia*, 164
Nucula, 149
tenuis, 149
Nuculana, 150
minuta, 150
radiata, 151
Obesotoma, 132
simplex, 133
tenuilata, 132
obscura, *Solariella*, 80
occidentalis, *Ptychactractus*, 129
occulta, *Cylichna*, 140
Odostomia, 141
cassandra, 141
Oenopota, 134
harpa, 134
nazanensis, 134
tenuicostata, 134
"Oenopota" elegans, 135
harpularia, 135
pyramidalis, 136
Onchidiopsis, 92
glacialis, 92
groenlandica, 93
orbiculata, *Axinopsida*, 172
pacificus, *Boreotrophon*, 100
pallidus, *Polinices*, 91
Panomya, 189
ampla, 190
arctica, 189
perversa, *Triphora*, 87
Piliscus, 93
commodus, 93
planata, *Montacuta*, 174
plectrum, *Buccinum*, 105
plicatilis, *Velutina*, 96
Plicifusus, 126
kroyeri, 126
polare, *Buccinum*, 108
Polinices, 91
monteronus, 91
pallidus, 91
pribilofensis, *Margaritopsis*, 79
pseudoarenaria, *Mya*, 186
Pseudopythina, 173
compressa, 173
Ptychactractus, 129
occidentalis, 129
Puncturella, 74
noachina, 74
pyramidalis, *"Oenopota"*, 136
Pyrulofusus, 114
deformis, 114
radiata, *Nuculana*, 151
Raphitoma, 137
amoena, 137
regina, *Admete*, 131
reticulatum, *Tachyrhynchus*, 86
Retusa, 138
umbilicata, 138
salmonacea, *Corypbella*, 145
scissurata, *Yoldia*, 154
Serripes, 176
grönländicus, 176
simplex, *Obesotoma*, 133
Solariella, 80
obscura, 80
sovaliki, *Mysella*, 173
Spiratella, 142
helicina, 142
spitzbergensis, *Colus*, 119
stefanssoni, *Volutopsis*, 128
stimpsoni, *Beringius*, 115
Symmetrogephyrus, 147
vestitus, 147
Tachyrhynchus, 86
reticulatum, 86
Tellina, 180
lutea, 180
tenuis, *Buccinum*, 107
tenuicostata, *Oenopota*, 134
tenuilata, *Obesotoma*, 132
tenuis, *Nucula*, 149
Thracia, 162
adamsi, 163
myopsis, 162
Thyasira, 171
flexuosa, 171
Trachydermon, 145
albus, 145
Trichotropis, 88
bicarinata, 88
borealis, 88
kroyeri, 89
Triphora, 87
perversa, 87
truncata, *Mya*, 184
truncatus, *Boreotrophon*, 101
turneri, *Aquilonaria*, 83
umbilicata, *Retusa*, 138
undata, *Velutina*, 94
undatum, *Buccinum*, 114
vahli, *Margarites*, 79
velutina, *Velutina*, 95
Velutina, 94
lanigera, 97
plicatilis, 96
undata, 94
velutina, 95
ventricosa, *Neptunea*, 121
vestitus, *Symmetrogephyrus*, 147
Volutopsis, 128
stefanssoni, 128
Yoldia, 151
arctica, 151
hypoborea, 152
myalis, 152
scissurata, 154
zetlandica, *Aldisa*, 143

SPECIES NAMES IN SYNONYMY

- Admete crispa*, 129
middendorffiana, 129
Aeolis papillosa, 145
alaskana, *Venericardia*, 169
alba, *Lepeta*, 73
Lepidochitona, 145
albus, *Chiton*, 145
Amicula vestita, 147
Amphispheya expansa, 139
globosa, 139
amoenus, *Gonatus*, 148
Amphitrite frondosa, 144
ampla, *Panomya*, 189
Panope, 189
aniwana, *Liocyma*, 177
arborescens, *Dendronotus*, 144
Doris, 144
Arca minuta, 150
tenuis, 149
arctica, *Astarte*, 165
Glycimeris, 189
Ieda, 151
Nucula, 151
Panopaea, 189
Portlandia, 151
Saxicava, 190
Astarte arctica, 165
banksii, 167
crassidens, 170
fabula, 167
globosa, 167
pulchella, 167
richardsoni, 165
semisulcata, 165
striata, 167
warhami, 167
Axinus flexuosus, 171
gouldii, 171
sarsii, 171
banksii, *Astarte*, 167
Nicania, 167
beckii, *Liocyma*, 177
behringii, *Tritonium*, 117

- Bela elegans*, 135
harpa, 134
harpularia, 135
impressa, 137
laevigata, 133
pyramidalis, 136
simplex, 133
tenuicostata, 134
tenuilrata, 132
beringi, *Trophon*, 99
Volutopsius, 117
Beringius malleatus, 115
bicarınatus, *Turbo*, 88
Boreotrophon multıcostatus, 98
buccinoides, *Cancellaria*, 129
Buccinum carınatum, 102
cnımatopleura, 109
orotundum, 108
morchianum, 102
polaris, 108
pyramıdale, 136
saturum, 121
stımpsoni, 115
truncatum, 101
ventriosum, 121
Bulla debilis, 139
hiemalis, 139
hyalina, 139
oculta, 140
plleatilis, 96
reinhardtı, 140
scalpta, 140
striata, 140
subangulata, 139
umbilicata, 138
velutina, 95
caeca, *Patella*, 73
calcareo, *Tellina*, 181
Cancellaria buccinoides, 129
couthouyi, 129
mıddendorffiana, 130
viridula, 129
candida, *Diaphana*, 139
candidus, *Utricleus*, 139
Cardium ciliatum, 176
grönlandicum, 176
carınatum, *Buccinum*, 102
Tritonium, 102
castanea, *Rissoa*, 84
Cerithium perversum, 87
Chiton albus, 145
vestitus, 147
Chrysodomus heros, 122
saturus, 121
solutus, 122, 124
variciferus, 121
ciliatum, *Cardium*, 176
Tritonium, 113
cinerea, *Margarita*, 75
Margarites, 75
cinereus, *Turbo*, 75
clathratus, *Murex*, 98
Trophon, 98
Clio helicina, 142
limacina, 143
cnımatopleura, *Buccinum*, 109
coeca, *Lepeta*, 73
Colus spitsbergensis, 119
commodum, *Filidium*, 93
compressa, *Venus*, 167
coriacea, *Helix*, 96
Velutina, 97
corneus, *Turbo*, 75
corrugata, *Modiolaria*, 158
corrugatus, *Mytilus*, 158
costalis, *Trochus*, 75
costulata, *Margarita*, 81
couthouyi, *Cancellaria*, 129
crassidens, *Astarte*, 170
Venericardia, 170
crebrıcostata, *Venericardia*, 169
crispa, *Admete*, 129
Cryptodon gouldii, 171
cryptospira, *Velutella*, 96
Velutina, 96
curta, *Thracia*, 162
Cylichna nitidula, 138
propinqua, 140
sollitaria, 140
strigella, 138
debilis, *Bulla*, 139
deformis, *Fusus*, 114
Defrancia elegans, 135
vahlıi, 136
woodiana, 135
Dendronotus arborescens, 144
despecta, *Neptunea*, 124
Diaphana candida, 139
expansa, 139
glacialis, 139
globosa, 139
hiemalis, 139
hyalina, 139
spirata, 139
discors, *Modiolaria*, 159
Mytilus, 159
Doris arborescens, 144
zetlandica, 143
elegans, *Bela*, 135
Defrancia, 135
elevata, *Montacuta*, 174
Eolis salmonacea, 145
Epitonium grönlandicum, 83
Euspira monterona, 91
expansa, *Amphisphyra*, 139
Diaphana, 139
Nucula, 149
fabrici, *Onychoteuthis*, 148
fabula, *Astarte*, 167
flexuosa, *Lucina*, 171
Tellina, 171
flexuosus, *Axinus*, 171
fluctuosus, *Fusus*, 177
Venus, 177
fornicatus, *Fusus*, 122
frondosa, *Amphitrite*, 144
Fusus deformis, 114
fornicatus, 122
harpularius, 135
lamellosus, 98
pleurotomarius, 136
scalariformis, 98
spitzbergensis, 119
vertkruzeni, 126
glaber, *Polypus*, 149
glacialis, *Diaphana*, 139
Lamellaria, 92
globosa, *Amphisphyra*, 139
Astarte, 167
Diaphana, 139
Glycimeris arctica, 189
Gonatus amoenus, 148
gouldii, *Axinus*, 171
Cryptodon, 171
Lucina, 171
Thyasira, 171
grönlandica, *Scalaria*, 83
grönlandicum, *Epitonium*, 83
grönlandicus, *Serripes*, 176
grönlandicum, *Cardium*, 176
grosvenori, *Margarites*, 80
gunneri, *Tritonium*, 98
harpa, *Bela*, 134
harpularia, *Bela*, 135
Lora, 135
harpularius, *Fusus*, 135
helicina, *Clio*, 142
Limacina, 142
Helix coriacea, 96
heros, *Chrysodomus*, 122
hiemalis, *Bulla*, 139
Diaphana, 139
hokkaidensis, *Octopus*, 149
Polypus, 149
hyalina, *Bulla*, 139
Diaphana, 139
hypoborea, *Nucula*, 152
impressa, *Bela*, 137
Pleurotoma, 137
incongrua, *Tellina*, 180
intermedia, *Mya*, 186
islandicus, *Pecten*, 155
jan-mayeni, *Rissoa*, 85
kobelti, *Volutopsius*, 117
krausei, *Macoma*, 182
kroyeri, *Sipho*, 126
laevigata, *Bela*, 133
Modiola, 159
Modiolaria, 159
Velutina, 95
laevigatus, *Musculus*, 159
Lamellaria glacialis, 92
lamellosus, *Fusus*, 98
Leda arctica, 151
minuta, 150
radiata, 151
Lepeta alba, 73
coeca, 73

- Lepidochitona alba*, 145
limacina, *Clio*, 143
Limacina helicina, 142
pacifica, 142
Liocyma aniwana, 177
beckii, 177
scammoni, 177
schefferi, 177
viridis, 177
Lora harpularia, 135
nazanensis, 134
tenuilirata, 132
Lucina flexuosa, 171
gouldii, 171
Lunatia pallida, 91

Macoma krausei, 182
oneilli, 182
malleata, *Strombella*, 115
malleatus, *Beringius*, 115
Margarita cinerea, 75
costulata, 81
sordida, 75
striata, 75
vahlhi, 79
Margarites cinerea, 75
grosvenori, 80
pribiloffensis, 79
sordida, 75
martensi, *Sipho*, 120
middendorffiana, *Admete*, 129
Cancellaria, 130
minuta, *Arca*, 150
Leda, 150
Modiola laevigata, 159
nigra, 157
Modiolaria corrugata, 158
discors, 159
laevigata, 159
nigra, 157
moesta, *Tellina*, 182
mollerii, *Montacuta*, 174
Mysella, 174
Montacuta elevata, 174
mollerii, 174
montagui, *Venus*, 167
monterona, *Euspira*, 91
Polinices, 91
morchianum, *Buccinum*, 102
Morvillia undata, 94
multicostatus, *Boreotrophon*, 98
Murex, 98
Murex clathratus, 98
multicostatus, 98
Musculus laevigatus, 159
Mya intermedia, 186
norvegica, 164
striata, 164
truncata, 190
myalis, *Nucula*, 152
Mysella mollerii, 174
planata, 174
Mytilis corrugatus, 158
discors, 159
Natica pallida, 91
nazanensis, *Lora*, 134

Neptunea despecta, 124
soluta, 124
vinosa, 124
Nicania banksii, 167
striata, 167
nigra, *Modiola*, 157
Modiolaria, 157
nitidula, *Cylichna*, 138
nitidulus, *Utricleus*, 138
noachina, *Patella*, 74
norvegica, *Mya*, 164
Nucula arctica, 151
expansa, 149
hyperborea, 152
myalis, 152
obscurus, *Turbo*, 80
occulta, *Bulla*, 140
Octopus hokkaidensis, 149
oneilli, *Macoma*, 182
Onychoteuthis fabricii, 148
orotundum, *Buccinum*, 108

pacifica, *Limacina*, 142
Spiratella, 142
Trophon, 100
pacificus, *Trophon*, 100
pallida, *Lunatia*, 91
Natica, 91
Polinices, 91
Panomya ampla, 189
turgida, 189
Panopaea arctica, 189
Pauope ampla, 189
papillosa, *Aeolis*, 145
Patella caeca, 73
noachina, 74
paucicostata, *Venericardia*, 170
Pecten islandicus, 155
Peronidia venulosa, 180
perversum, *Cerithium*, 87
perversus, *Trochus*, 87
Pilidium commodum, 93
radiatum, 93
planta, *Mysella*, 174
Rocheortia, 174
Tellimya, 174
Pleurotoma impressa, 137
pyramidalis, 136
simplex, 133
tenuicostata, 134
pleurotomarius, *Fusus*, 136
plicatilis, *Bulla*, 96
Plicifusus verkruzeni, 126
polaris, *Buccinum*, 108
Polinices monterona, 91
pallida, 91
Polypus glaber, 149
hokkaidensis, 149
Portlandia arctica, 151
pribiloffensis, *Margarites*, 79
propinqua, *Cylichna*, 140
pulchella, *Astarte*, 167
pyramidale, *Buccinum*, 136
pyramidalis, *Bela*, 136
Pleurotoma, 136

radiata, *Leda*, 151
radiatum, *Pilidium*, 93
reinhardtii, *Bulla*, 140
reticulata, *Turritella*, 86
richardsoni, *Astarte*, 165
Rissoa castanea, 84
jan-mayeni, 85
Rocheortia planata, 174

salmonacea, *Eolis*, 145
sarsii, *Axinus*, 171
saturum, *Buccinum*, 121
saturus, *Chrysodomus*, 121
Saxicava arctica, 190
Scalaria greenlandica, 83
scalariformis, *Fusus*, 98
Trophon, 98
scalpta, *Bulla*, 140
scammoni, *Liocyma*, 177
schefferi, *Liocyma*, 177
schneideri, *Velutina*, 95
semisulcata, *Astarte*, 165
Serripes groenlandicus, 176
simplex, *Bela*, 133
Pleurotoma, 133
Sipho kroyeri, 126
martensi, 120
sitkensis, *Velutina*, 96
solitaria, *Cylichna*, 140
soluta, *Neptunea*, 124
solutus, *Chrysodomus*, 122, 124
sordida, *Margarita*, 75
Margarites, 75
spirata, *Diaphana*, 139
Spiratella pacifica, 142
spitsbergensis, *Colus*, 119
spitzbergensis, *Fusus*, 119
stimpsoni, *Buccinum*, 115
striata, *Astarte*, 167
Bulla, 140
Margarita, 75
Mya, 164
Nicania, 167
strigella, *Cylichna*, 138
Strombella malleata, 115
subangulata, *Bulla*, 139

Tapes fluctuosa, 177
Tellimya planata, 174
Tellina calcarea, 181
flexuosa, 171
incongrua, 180
moesta, 182
tenuicostata, *Bela*, 134
tenuilirata, *Bela*, 132
Lora, 132
tenuis, *Arca*, 149
Thracia curta, 162
Thyasira gouldii, 171
Tritonium behringii, 117
ciliatum, 113
carinatum, 102
gunneri, 98
Trochus costalis, 75
perversus, 87

Trophon beringi, 99	Utriculus candidus, 139	venulosa, Peronidia, 180
clathratus, 98	nitidulus, 138	Venus compressa, 167
pacifica, 100	umbilicatus, 138	flexuosa, 171
pacificus, 100		fluctuosa, 177
scalariformis, 98	vahlil, Defrancia, 136	montagui, 167
truncatus, 101	Margarita, 79	verkruzeni, Fusus, 126
truncata, Mya, 190	variciferus, Chrysodomus, 121	Plucifusus, 126
truncatum, Buccinum, 101	Velutella cryptospira, 96	vestita Amicula, 147
truncatus, Trophon, 101	velutina, Bulla, 95	vestitus, Chiton, 147
Turbo bicarinatus, 88	Velutina cryptospira, 96	vinosa, Neptunea, 124
cinereus, 75	laevigata, 95	viridis, Lioecyma, 177
corneus, 75	schneideri, 95	viridula, Cancellaria, 129
obscurus, 80	sitkensis, 96	Volutopsius beringi, 117
turgida, Panomya, 189	undatum, 94	kobelti, 117
Turritella reticulata, 86	zonata, 94	
	Venericardia alaskana, 169	warhami, Astarte, 167
umbilicata, Bulla, 138	crassidens, 170	woodiana, Defrancia, 135
umbilicatus, Utriculus, 138	crebricostata, 169	
undata, Morvillia, 94	paucicostata, 170	zetlandica, Doris, 143
undatum, Velutina, 94	ventricosum, Buccinum, 121	zonata, Velutina, 94

References

- ABBOTT, R. TUCKER
 1954. American seashells. 541 pp., 40 pls. (1-16, 33-40 in color), 100 text figs.
- ADAMS, ARTHUR
 1851. Descriptions of new shells, from the Cumington Collection; with a note on the genus *Nematura*. Proc. Zool. Soc. London, pp. 224-225.
- ALDER, JOSHUA, AND HANCOCK, ALBANY
 1845-1855. A monograph of the British nudibranchiate Mollusca
 Pts. 1-7, 80 pls. [Fam. 1, pls. 1-27; fam. 2, pls. 1-5; fam. 3, pls. 1-48].
 1910. A monograph of the British nudibranchiate Mollusca . . . with a supplement by Sir C. Eliot. Pt. 8 (Supplementary), col. illus.
- ASCANIUS, PEDER
 1774. Beskrivelse over en norsk sneppe og et sødyr. K. Norske Vid. Selsk. Skrift., vol. 5, pp. 153-158.
- BARTSCH, PAUL
 1921. Observations on living gastropods of New England. Nautilus, vol. 35, pp. 85-90.
 1941. The nomenclatorial status of certain northern turritid mollusks. Proc. Biol. Soc. Washington, vol. 54, pp. 1-14, pl. 1.
- BARTSCH, PAUL AND REHDER, HARALD A.
 1939. Two new marine shells from the Aleutian Islands. Nautilus, vol. 52, No. 4, pp. 110-112, pl. 8.
- BECK, H.
 1842. In Möller (see Möller, 1842b).
- BEECHY, FREDERICK WILLIAM
 1839. The zoology of Captain Beechey's voyage . . . in HMS *Blossom* xii+186, pp., 44 col. pls., 3 col. maps.
- BELCHER, SIR EDWARD
 1855. The last of the Arctic voyages; being a narrative of the expedition in HMS *Assistance* . . . in search of Sir J. Franklin, during . . . 1852-54. With notes on the natural history by Sir J. Richardson Vols. 1-2, illus. [Vol. 2 contains "Account of the shells collected . . . north of Beechey Island," by L. Reeve.]

BERGH, L. S. RUDOLF

1853. Bidrag til en Monographi af Marseniaderne. K. Danske Vidensk. Selsk. Skrift. R. 5, Naturv. Afd., vol. 3, pp. 239-359, pls. 1-5.
 1864. Anatomiske Bidrag til Kundskab om Aelidierne. K. Danske Vidensk. Selsk. Skrift., ser. 5, vol. 7, pp. 141-316, pls. 1-9.
 1887. Malacologische Untersuchungen. Suppl. IV. Die Marseniaden, pt. 2, pp. 226-284, pls. P-V, X-Z, and AE. *In* Semper, Reisen im Archipel der Philippinen . . . , vol. 2.

BERRY, S. STILLMAN

1912. A review of the cephalopods of western North America. Bull. U. S. Bur. Fisheries, vol. 30 [for 1910], pp. 267-336, figs. 1-18, pls. 32-56.
 1921. Notes on some Japanese cephalopods. A review of Sasaki's *Albatross* report. Ann. Mag. Nat. Hist., ser. 9, vol. 8, pp. 351-353.

BRODERIP, W. J., AND SOWERBY, G. B.

1829. Observations on new or interesting Mollusca contained, for the most part, in the Museum of the Zoological Society. Zool. Journ., vol. 4, No. 15, art. 48, pp. 359-379, pl. 9.

BROWN, THOMAS

1827. Illustrations of the Recent conchology of Great Britain and Ireland. Ed. 1, xiii+144 pp., 20 pls.
 1844. Illustrations of the Recent conchology of Great Britain and Ireland. Ed. 2 xiii+144 pp., 59 col. pls.
 [1838-] 1849. Illustrations of the Fossil conchology of Great Britain and Ireland. viii+273 pp., 116 pls. (15 col.).

BRUGUIÈRE, J. G.

1789. Encyclopedie methodique; histoire naturelle des vers, des mollusques, des coquillages et zoophytes. Histoire naturelle des vers. Vol. 1, pp. 1-757.
 1792. [The same as 1789, unaltered.]

BURCH, JOHN Q.

- 1945-1946. Distributional list of the west American marine mollusks from San Diego, California to the Polar Sea. Pt. I, pelecypods; pt. II, gastropods, vol. 1 (Nos. 46-54), vol. 2 (Nos. 55-63). By various authors, edited by John Q. Burch. From Proc. Conch. Club Southern California. [Mimeographed.]

CLENCH, WILLIAM J., AND SMITH, L. C.

1944. The family Cardiidae in the western Atlantic. *Johnsonia*, vol. 1, No. 13, pp. 1-32, pls. 1-13.

CLENCH, WILLIAM J., AND TURNER, RUTH D.

1952. The genus *Epitonium* in the western Atlantic. *Johnsonia*, vol. 2, No. 31, pt. 2, pp. 289-356, pls. 131-177.

COUTHOUY, JOSEPH P.

1838. Descriptions of new species of Mollusca and shells, and remarks on several polypi found in Massachusetts Bay. Boston Journ. Nat. Hist., vol. 2, No. 1, pp. 53-111, pls. 1-3.
 1839. Monograph of the family Osteodesmacea of Deshayes, with remarks on two species of Patelloidea, and descriptions of new species of marine shells, a species of *Anculotus*, and one of *Eolis*. Boston Journ. Nat. Hist., vol. 2, No. 2, pp. 129-189, pl. 4.

DALL, WILLIAM HEALEY

- 1870a. Materials for a monograph of the family Lepetidae. Amer. Journ. Conch., vol. 5, pt. 3, No. 3, pp. 140-150, pl. 15.

- 1870b. Revisions of the classification of the Mollusca of Massachusetts. Proc. Boston Soc. Nat. Hist., vol. 13, pp. 240-257.
1871. Descriptions of sixty new species of mollusks from the west coast of North America and the north Pacific Ocean, with notes on others already described. Amer. Journ. Conch., vol. 7, pp. 93-160, pls. 13-16.
1877. Preliminary descriptions of new species of mollusks from the north-west coast of America. [Published out of series as a separate, pp. 1-6. Cited as "From the Proc. Calif. Acad. Sci., March 19, 1877."] 1885a. New or especially interesting shells of the Point Barrow Expedition. Proc. U. S. Nat. Mus., vol. 7, pp. 523-526.
- 1885b. Mollusks. In Report of the International Polar Expedition to Point Barrow, Alaska, 1881-1883 (see Ray, Lt. P. H.), pt. 4, natural history, art. 6, pp. 177-184, 1 pl.
1886. Supplementary notes on some species of mollusks of the Bering Sea and vicinity. Proc. U. S. Nat. Mus., vol. 9, pp. 297-309, pls. 3, 4.
1887. Report on the mollusks collected by L. M. Turner at Ungava Bay, North Labrador, and from the adjacent Arctic Seas. Proc. U. S. Nat. Mus., vol. 9, pp. 202-208, pl. 3
1898. Contributions to the Tertiary fauna of Florida. Trans. Wagner Free Inst. Sci. Philadelphia, vol. 3, pt. 4, pp. 571-947, pls. 23-35.
1899. Synopsis of the Recent and Tertiary Leptonacea of North America and the West Indies. Proc. U. S. Nat. Mus., vol. 21, No. 1177, pp. 873-897, pls. 87, 88.
1900. Synopsis of the family Tellinidae and of the North American species. Proc. U. S. Nat. Mus., vol. 23, No. 1210, pp. 285-326, pls. 2-4.
1901. Synopsis of the Lucinacea and of the American species. Proc. U. S. Nat. Mus., vol. 23, No. 1237, pp. 779-833, pls. 39-42.
1902. Illustrations and descriptions of new, unfigured, or imperfectly known shells, chiefly American, in the United States National Museum. Proc. U. S. Nat. Mus., vol. 24, No. 1264, pp. 499-566, pls. 27-40.
- 1903a. Synopsis of the family Astartidae, with a review of the American species. Proc. U. S. Nat. Mus., vol. 26, No. 1342, pp. 933-951, pls. 62, 63.
- 1903b. Synopsis of the Carditacea and of the American species. Proc. Acad. Nat. Sci. Philadelphia, vol. 24, pp. 696-716.
1907. Descriptions of new species of shells, chiefly Buccinidae, from the dredgings of the U. S. S. *Albatross* during 1906, in the northwest Pacific, Bering, Okhotsk, and Japanese Seas. Smithsonian Misc. Coll., vol. 50, No. 1727, pp. 139-173.
1911. A giant *Admete* from Bering Sea. Nautilus, vol. 25, No. 2, pp. 19, 20.
1916. Diagnoses of new species of marine bivalve mollusks from the north-west coast of America in the collection of the United States National Museum. Proc. U. S. Nat. Mus., vol. 52, No. 2183, pp. 393-417.
1918. Notes on *Chrysodomus* and other mollusks from the north Pacific Ocean. Proc. U. S. Nat. Mus., vol. 54, No. 2234, pp. 207-234.
- 1919a. Descriptions of new species of mollusks of the family Turritidae from the west coast of America and adjacent regions. Proc. U. S. Nat. Mus., vol. 56, No. 2288, pp. 1-86, pls. 1-24.
- 1919b. Descriptions of new species of Mollusca from the north Pacific Ocean in the collection of the United States National Museum. Proc. U. S. Nat. Mus., vol. 56, No. 2295, pp. 293-371.

- 1919c. The molluscs of the Arctic coast of America collected by the Canadian Arctic Expedition west from Bathurst Inlet with an appended report on a collection of Pleistocene fossil Mollusca. *In* Report Canadian Arctic Expedition, 1913-18, vol. 8, pt. A, Mollusks, pp. 3-29, pls. 1-3.
1921. Summary of the marine shellbearing mollusks of the northwest coast of America, from San Diego, California, to the Polar Sea, mostly contained in the collection of the United States National Museum, with illustrations of hitherto unfigured species. U. S. Nat. Mus. Bull. 112, pp. 1-216, pls. 1-22.
1924. Supplement to the report of the Canadian Arctic Expedition 1913-18. Vol. 8, pt. A, Mollusca, pp. 31-35, 1 pl.
1925. Illustrations of unfigured types of shells in the collection of the United States National Museum. Proc. U. S. Nat. Mus., vol. 66, art. 17, pp. 1-41, pls. 1-36.
1926. A new *Margarites* from Greenland. Proc. Biol. Soc. Washington, vol. 39, p. 59.
- DALL, WILLIAM HEALEY, AND BARTSCH, PAUL
1913. New species of mollusks from the Atlantic and Pacific coasts of Canada. Victoria Mem. Mus. Bull. No. 1, pp. 139-144, pl. 10.
- DESHAYES, M. G. P.
1854. Descriptions of new shells from the collection of Hugh Cuming, Esquire. Proc. Zool. Soc. London, pt. 22, pp. 317-371.
- DILLWYN, L. W.
1817. A descriptive catalogue of Recent shells, arranged according to the Linnaean methods; with particular attention to the synonymy. Pt. I, pp. 1-580.
- DUNKER, WILHELM
- 1858-1870. Beschreibung . . . neuer . . . meeres Conchylien. Novitates Conchologicae. Mollusca Marina. iv + 144 pp., 45 col. pls.
- ESCHSCHOLTZ, J. F. VON
- 1829-1833. Zoologischer Atlas, enthaltend Abbildungen und Beschreibungen neuer Thierarten, während des Flottecapitains von Kotzebue zweiter Reise um die Welt . . . in . . . 1823-26 beobachtet von . . . F. Eschscholtz. 5 pts. (in 1 volume), col. illus.
- FABRICIUS, O.
- 1776 [1774-1822]. Fauna Groenlandica, systematice sistens Animalis Groenlandiae occidentalis haecenus indagata . . . maximaque parte secundum proprias observationes O. Fabricii. xvi + 452 pp., 1 pl.
1780. Fauna Groenlandica Ed. 2, xvi + 452 pp., 1 pl., 12 figs.
- FARFANTE, ISABEL PEREZ
1947. The genera *Zeidora*, *Nesta*, *Emarginula*, *Rimula*, and *Puncturella* in the western Atlantic. Johnsonia, vol. 2, No. 24, pp. 93-148, pls. 41-64.
- FISCHER, P.
- 1873-1880. Spécies général et iconographie des Coquilles vivantes . . . continué par . . . P. Fischer. Livr. 139-165. (See also Kiener, 1834-1850.)
- FORBES, EDWARD
1846. Catalogue of species of marine animals, the remains of which are found fossil in beds of the Glacial Epoch (living in Gulf of St. Lawrence). Append. Mem. Geol. Surv. Great Britain Mus. Econ. Geol., vol. 1, pp. 406-432.

FOSTER, RICHARD

1946. The genus *Mya* in the western Atlantic. *Johnsonia*, vol. 2, pp. 29-35, pls. 20, 21.

FRIELE, HERMAN

1878. Jan Mayen Mollusca from the Norwegian North Atlantic Expedition in 1877. *Nyt Mag. Naturv.*, vol. 24, pp. 221-226.
1886. Den Norske Nordhavs-Ekspedition 1876-78. *Zoologi. Mollusca II*, pp. 1-43, pls. 7-12.

GARDNER, JULIA

1916. Mollusca. *In* Maryland Geological Survey, Upper Cretaceous. Pp. 371-733, pls. 12-45.

GMELIN, J. F.

- 1788-1793. *In* Linnaeus, *Systema naturae*, ed. 13 [revised and augmented by Gmelin], vols. 1-3 [in 7 vols.].

GOULD, A. A.

1840. Dr. A. A. Gould read descriptions of the following species of shells. *Silliman's Journ.* (now *Amer. Journ. Sci.*), vol. 38, No. 1, pp. 196-197.
1841. A report on the Invertebrata of Massachusetts. xiii + 373 pp., 213 figs.
1860. A. A. Gould presented the following descriptions of new shells collected by the U. S. North Pacific Exploring Expedition. *Proc. Boston Soc. Nat. Hist.*, vol. 7, pp. 323-340.
1870. A report on the Invertebrata of Massachusetts. Ed. 2., comprising the Mollusca. Edited by W. G. Binney. v + 524 pp., pls. 16-27 col., figs. 350-755.

GRANT, U. S., IV, AND GALE, HOYT RODNEY

1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions. *Mem. San Diego Soc. Nat. Hist.*, vol. 1, pp. 1-1036, figs. 1-15, pls. 1-32.

GRAY, J. E.

1824. Shells. *In* A supplement to the appendix to Parry's first voyage. Appendix 10. *Nat. Hist.*, No. 10, *Zool.*, pp. 240-246.
1839. Molluscous animals and their shells. *In* Beechey, The zoology of Captain Beechey's voyage, pp. 101-155, pls. 33-44 (hand colored by G. B. Sowerby).
1847a. A list of the genera of Recent Mollusca, their synonyma and types. *Proc. Zool. Soc. London*, pt. 15, pp. 129-219. (Also, *in* M. E. Gray, 1842-1859, vol. 4, pp. 1-124.)
1847b. On the genera of the family Chitonidae. *Proc. Zool. Soc. London*, pt. 15, pp. 63-70.
1850. Description of a new species of *Chrysodomus*, from the mouth of the Mackenzie River. *Proc. Zool. Soc. London*, pt. 18, pp. 14-15, pl. 7.

GRAY, M. E. (Mrs.)

- 1842-1859. Figures of molluscous animals, selected from various authors. 5 vols.

HÄGG, R.

1905. Mollusca und Brachiopoda gesammelt von der schwedischen zoologischen Polarexpedition nach Spitzbergen, dem nord-östlichen Grönland und Jan Mayen im Jahre 1900. *Arkiv für Zool.*, vol. 2, No. 13, pp. 1-136, pl. 1.

HANCOCK, ALBANY

1846. A list of shells dredged on the west coast of Davis's Strait; with notes and descriptions of eight new species. *Ann. Mag. Nat. Hist.*, ser. 1, vol. 18, pp. 323-338, pl. 5.

HERMANN, D. JOHANN

1781. Erster Brief über einige Conchylien an der Herausgeber. *Der Naturforscher*, vol. 16, pp. 50-56, pl. 2.

HIRASE, YOICHIRO

1907. On Japanese marine molluscs. XI. *Conchological Mag.*, vol. 1, No. 11, pp. 352-362, pls. 19, 20.

HIRASE, SHINTARO

1951. An illustrated handbook of shells in natural colors from the Japanese Islands and adjacent territory. Revised and enlarged by Isao Tako. 134 pls. (130 in color).

HOYLE, W. E.

1886. Report on the Cephalopoda collected by HMS *Challenger* during the years 1873-1876. In *Voyage of the Challenger*, vol. 16, vi+245 pp., 33 pls., 1 fold map.

JAY, J. C.

1856. Report on the shells collected . . . together with a list of Japan shells. In M. C. Perry's report on the United States Expedition to Japan, vol. 2, pp. 291-297, pls. 1-5. (See Perry, M. C.)
1839. A catalogue of the shells in the collection of John C. Jay, M. D., with descriptions . . . Ed. 3, pp. 1-125, pls. 1-10.

JEFFREYS, JOHN GWYN

- 1865a. Further report on Shetland dredgings. *Rep. British Assoc. Adv. Sci.*, pp. 327-342.
- 1865b. British conchology. Vol. 3, Marine shells, pp. 1-394, pls. 1-8.

JENSEN, ADOLF S.

1901. Studier over nordiske Mollusker. I. *Mya*. *Vidensk. Medd. Naturh. Foren. København*, pp. 133-158.
1905. On the Mollusca of East Greenland. I. Lamellibranchiata. *Medd. Grønland*, vol. 29, pp. 287-362, 5 figs.
1912. Lamellibranchiata, pt. 1. The Danish *Ingolf*-Expedition, vol. 2, pt. 5, pp. 1-119, pls. 1-4.

JOHNSON, CHARLES W.

1934. List of marine Mollusca of the Atlantic coast from Labrador to Texas. *Proc. Boston Soc. Nat. Hist.*, vol. 40, No. 1, pp. 1-204.

JONES, T. RUPERT

1875. Manual of the natural history, geology, and physics of Greenland and the neighboring regions . . . Pp. vi, 1-86, xii, 1-783, text figs., 3 pls. [The "Manual" is pt. 2, art. 9, *Prodromus Faunae Molluscorum Groenlandiae* . . . Revised and augmented by O. A. L. Mörch.]

KEEN, A. MYRA

1937. An abridged check list and bibliography of west North American marine Mollusca, 87 pp.

KEEN, A. MYRA, AND FRIZZELL, DON L.

1939. Illustrated key to west North American pelecypod genera. 32 pp. (Revised ed., 1953.)

KEEN, A. MYRA, AND PEARSON, JOHN C.

1952. Illustrated key to west North American gastropod genera. 39 pp.

KIENER, LOUIS CHARLES

- 1834-1850. *Spécies général et iconographie des coquilles vivantes, comprenant la collection du Muséum d'Histoire Naturelle de Paris, la collection Lamarck, celle du Prince Masséna et les découvertes récentes des voyageurs.* [This work consists of 165 livraisons, 138 of which were by Kiener, 1834-50, the remainder published by P. Fischer in 1873-80. Livraisons 124-126, vol. 10, published in 1848, contain the text to *Conus* and the plates to *Turbo*. Livraisons 139-140, vol. 10, published in 1873, contain the text to *Turbo*.]

KINOSHITA, T., AND ISHAYA, T.

1934. Catalogue of molluscan shells of Hokkaido. First report, pp. 1-19. [In Japanese.]

KIRA, TETSUAKI

1954. An illustrated handbook of shells in natural colors. 172 + 24 pp., 67 col. pls.

KOBELT, W.

1876. Beiträge zur Aretischen Fauna. Jahrb. Deutschen Malako-Zool. Ges., vol. 3, pp. 61-76.
1877. Zur Kenntniss der nordischen Mollusken. Jahrb. Deutschen Malako-Zool. Ges., vol. 4, pp. 257-264.
1883+. Iconographie der schalentragenden Europäischen Meeresconchylien.

KRAUSE, ARTHUR

- 1885a. Ein Beitrag zur Kenntniss der Mollusken-Fauna des Beringsmeeres. I. Brachiopoda et Lamellibranchiata. Arch. Naturg., vol. 51, Heft 1, pp. 14-40, pl. 3.
1885b. Ein Beitrag zur Kenntniss der Mollusken-Fauna des Beringsmeeres. II. Gastropoda und Pteropoda. Arch. Naturg., vol. 51, Heft 1, pp. 257-302, pls. 16-18.

KURODA, TOKUBEI

1936. A list of the Buccinidae of northern Japan. Venus, vol. 6, No. 3, pp. 174-187. [In Japanese.]

LAMARCK, JEAN B. P. A. DE MONET DE

- 1815-1822. Histoire naturelle des animaux sans vertèbres . . . Ed. 1, vols. 1-7.
1835-1845. Histoire naturelle des animaux sans vertèbres . . . Ed. 2, Revue et augmentée de notes . . . par M. G. P. Deshayes et H. Milne Edwards. Vols. 1-11; Mollusques, vols. 1-5.

LAMY, EDOUARD, JR.

1919. Revision des Astartidae vivant du Museum d'Histoire Naturelle de Paris. Journ. Conchyliologie, vol. 64, No. 2, pp. 70-119, 3 figs.

LAROCQUE, AURELE

1953. Catalog of the Recent Mollusca of Canada. Bull. Nat. Mus. Canada, No. 129, pp. 1-406.

LEACH, WILLIAM E.

1819. A list of invertebrate animals, discovered by H. M. S. *Isabella*, in a voyage to the Arctic regions; corrected by . . . W. E. Leach. In Ross (1819), Appendix 2, pp. 61-62.

LECHE, WILHELM

1878. Öfver sigt öfver de af Svenska Expeditionerna till Novaja Semlja och Jenissej 1875 och 1876 Insamlade Hafs-Mollusker. Kongl. Svenska Vetensk.-Akad. Handl., new ser., vol. 16, No. 2, pp. 1-86, pls. 1, 2.

LEMICHE, HENNING

1938. Gastropoda Opisthobranchiata. Zoology of Iceland. Vol. 4, pt. 61, pp. 1-54, 3 figs.
 1941. Gastropoda Opisthobranchiata. Zoology of East Greenland. Medd. Grønland, vol. 121, No. 7, pp. 1-50, 6 figs.
 1948. Northern and Arctic tectibranch gastropods. I. The larval shells.
 II. A revision of the cephalaspid species. Kongl. Danske Vidensk. Selskab. Biol. Skrift., vol. 5, No. 3, pp. 1-136, figs. 1-80.

LICHTENSTEIN, K. M. H.

- 1818a. *Oyechoteuthis*, Sepien mit Krallen. Isis, pp. 1591-1592, pl. 19.
 1818b. [A separate of 1818a, with different pagination.]

LINNAEUS, CARL

1758. Systema naturae. Ed. 10, vols. 1, 2.
 1761. Fauna Suecica. Ed. 2, pp. xlv, 1-578.
 1767. Systema naturae. Ed. 12, vols. 1-3, illus.
 1771. Mantissa plantarum altera, generum editionis 6, et specierum editionis 2. Appendix, pp. 544-552, vermes testacea.

LOVÉN, S.

1846. Index mulluscorum litora Scandinaviae occidentalia habitantium, Holmiae. Ofv. Kongl. Vetensk.-Akad. Förhandl., vol. 3, No. 5, pp. 135-161.

MACGINITIE, G. E.

1955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. Smithsonian Misc. Coll., vol. 128, No. 9, 201 pp., 8 pls.

MADSEN, F. JENSENIUS

1949. Marine bivalvia. Zoology of Iceland. Vol. 4, pt. 63, pp. 1-116, figs. 1-12.

MARTENS, E. VON

1865. Descriptions of new species of shells. Ann. Mag. Nat. Hist., ser. 3, vol. 16, pp. 428-432.

MARTINI, F. H. W., and CHEMNITZ, J. H.

- 1769-1829. Neues systematisches Conchylien-Cabinet. 12 vols., col. illus.
 1883 [1837-1906]. Systematisches Conchylien-Cabinet. 11 vols. [In many vols.]

MARTYN, THOMAS

- 1784-1787 [1792]. The universal conchologist, exhibiting the figure of every known shell . . . drawn . . . and painted . . . with a new systematic arrangement. Ed. 2 (1784), vols. 1-4, 161 hand-col. pls. (A second title to vol. 1 reads "Figures of nondescript shells . . .")

MIDDENDORFF, A. TH. VON

- 1849a. Vorläufige Anzeige neuer Konchylien aus den Geschlechtern: *Littorina*, *Tritonium*, *Bullia*, *Natica* und *Margarita*. Bull. Physico-Math. P'Acad. Imper. Sci. St. Petersbourg, vol. 7, No. 16, pp. 241-246.
 1849b. Vorläufige Anzeige einiger neuer Konchylien Russland's, aus den Geschlechtern: *Scalaria*, *Crepidula*, *Velutina*, *Trichotropis*, *Purpura*, und *Pleurotoma*. Bull. Physico-Math. Acad. Imper. Sci. St. Petersbourg, vol. 8, Nos. 1, 2, pp. 18, 19.
 1849c. [A separate of 1849d, pt. 2, pp. 1-187, pls. 1-11; pt. 3, pp. 1-94, pls. 12-21.]

- 1849d. Beiträge zu einer malacozoologia Rossica. Pt. 2. Aufzählung und Beschreibung der zur Meeresfauna Russlands gehörigen Einschaler. Pt. 3. Aufzählung und Beschreibung der zur Meeresfauna Russlands gehörigen Zweischaler. Mem. Acad. Imper. Sci. St. Petersburg, ser. 6, vol. 6 [but vol. 8 of Sci. Math., Physiques et Naturelles]. Pt. 2, pp. 329-516, pls. 1-11. Pt. 3, pp. 517-610, pls. 12-21.
1851. Reise in den äussersten Norden und Osten Sibiriens während . . . 1843 und 1844 . . . Vol. 2, Zoologie, pt. 1, Wirbellose Thiere: Mollusken, pp. 163-464, 505-508, pls. 8-30.
- MIGHELS, J. W.
1841. In Mighels and Adams (see below).
- MIGHELS, J. W., AND ADAMS, C. B.
1841. Descriptions of twenty-five new species of New England shells. Proc. Boston Soc. Nat. Hist., vol. 1, pp. 48-50. [In Latin.]
1842. Descriptions of twenty-four species of the shells of New England. Boston Journ. Nat. Hist., vol. 4, No. 1, pp. 37-54, pl. 4, fig. 19. [In English.]
- MONTAGU, GEORGE
1803 [1803-1808]. Testacea Britannica, or natural history of British shells, marine, land, and fresh water. . . . Ed. 1, vols. 1, 2, and supplement, col. illus.
1815. An account of some new and rare marine British shells and animals. Trans. Linn. Soc. London, vol. 11, No. 2, pp. 179-204, pls. 12, 13.
- MÖLLER, H. P. C.
1842a. [A separate of 1842b. Pp. 1-24.]
1842b. Index molluscorum gronlandiae. Naturhist. Tidsskrift, ser. 1, vol. 4, No. 1, pp. 76-97.
- MÖRCH, O. A. L.
1857. Fortegnelse over Grønlands Bløddyr. In Rink, Grønland geographisk og statistisk beskrevet, vol. 2 (Naturhistoriske Bidrag), pt. 4, pp. 75-100. [A separate is titled "Prodromus molluscorum Grønlandiae," 28 pp.]
1869. Catalogue des mollusques du Spitzberg recueillis par le Dr. H. Krøyer pendant le voyage de la corvette la *Recherche* en Juin 1838. Mem. Soc. Malac. Belgique, vol. 4, pp. 9-32.
1871. Synopsis molluscorum marinorum Daniae. Fortegnelse over de i de Danske Have forekommende Bløddyr. Vidensk. Medd. Naturh. Foren. København, Nos. 11-14, pp. 157-226.
- MORRIS, PERCY A.
1947. A field guide to the shells of our Atlantic coast. 190 pp., 40 pls.
1951. A field guide to the shells of our Atlantic and Gulf coasts. 236 pp., 45 pls. (1-4 col.).
1952. A field guide to shells of the Pacific coast and Hawaii. 220 pp. pls. 1-40, plus color pls. 1-8.
- MÜLLER, O. F.
1776. Prodromus zoologiae Danicae. xxxii + 282 pp.
- NEAVE, S. A.
1939-1940. Nomenclator zoologicus. 5 vols.
- NICOL, DAVID
1955. An analysis of the Arctic marine pelecypod fauna. Nautilus, vol. 68, No. 4, pp. 115-122.

OCKELMANN, W. K.

1954. On the interrelationship and the zoogeography of northern species of *Yoldia* Möller, S. Str. (Mollusca, Fam. Lediidae) with a new sub-species. Medd. Grønland, vol. 107, No. 7, 32 pp., 2 text figs., 2 pls.

ODHNER, NILS

1907. Northern and Arctic invertebrates in the collection of the Swedish State Museum (Riksmuseum). III. Opisthobranchiata and Pteropoda. Kungl. Svenska Vetensk.-Akad. Handl., vol. 41, No. 4, pp. 1-118, pls. 1-3.
1910. Marine Mollusca of Iceland in the collections of the Swedish State Museum. Ark. für Zool., vol. 7, No. 4, pp. 1-31, illus.
1912. Northern and Arctic invertebrates in the collection of the Swedish State Museum (Riksmuseum). V. Prosobranchia. 1. Diotocardia. Kungl. Svenska Vetensk.-Akad. Handl., vol. 48, No. 1, pp. 1-93, pls. 1-7.
1913. Northern and Arctic invertebrates in the collection of the Swedish State Museum (Riksmuseum). VI. Prosobranchia. 2. Semi-proboscidifera. Kungl. Svenska Vetensk.-Akad. Handl., vol. 50, No. 5, pp. 3-89, pls. 1-5.
1915. Die Molluskenfauna des Eisfjordes. (Zool. Ergeb. Schwed. Exp. Spitsbergen, 1908.) Kungl. Svenska Vetensk.-Akad. Handl., vol. 54, No. 1, pp. 1-274, 13 pls., 4 text figs.
1922. Norwegian opisthobranchiate Mollusca in the collections of the Zoological Museum of Kristiania. Nyt Mag. Naturv., vol. 60, pp. 1-47.

OLDROYD, IDA SHEPARD

1924. The marine shells of the west coast of North America. Pelecypoda, vol. 1, No. 1, pp. 1-247, pls. 1-57. Stanford Univ. Publications, Univ. series, Geol. Sci.
1927. The marine shells of the west coast of North America. Gastropoda and Amphineura, vol. 2, pts. 1-3 [i. e., in 3 vols.], pls. 1-108. Stanford Univ. Publications, Univ. series, Geol. Sci.

PALLAS, P. S.

1788. Marina varia nova et rariora. XII. *Helix coriacea*. Nova Acta Acad. Sci. Imper. Petropolitanae, vol. 2 [for 1784], pp. 229-249, pl. 7.

PENNANT, T.

1812. British zoology. Ed. 5 (new), 4 vols., illus.

PERRY, GEORGE

1811. Conchology, or the natural history of shells: containing a new arrangement of the genera and species. Folio; 61 hand col. pls.

PERRY, M. C.

1856. Narrative of the expedition of an American squadron to the China Seas and Japan . . . in . . . 1852-54, under the command of Commodore M. C. Perry, U.S.N. Vols. 1-3, illust. [report on the natural history in vol. 2]. [A second edition of the narrative was published in 1856, but one edition was in quarto, the other in octavo.]

PHILIPPI, R. A.

- 1844-1847. Abbildungen und Beschreibungen neuer oder wenig bekannter Conchylien. Vol. 2 (in 8 pts.), pp. 1-232, 48 pls.
- 1845a. Bemerkungen über die Mollusken Fauna von Massachusetts. Zeitschr. Malakozool., Jahrgang 2, pp. 68-79.

- 1845b. Kritische Bemerkungen über einige *Trochus* Arten und die Gattung *Azinus*. Zeitschr. Malakozool., Jahrgang 2, pp. 87-91.
1849. Centuria tertia testaceorum novorum. Zeitschr. Malakozool., vol. 5, pp. 161-176.
- PHIPPS, CONSTANTINE JOHN
1774. A voyage towards the North Pole undertaken by His Majesty's Command, 1773. viii+253 pp., 11 pls., 3 maps. [The appendix covers pp. 77-253; natural history covers pp. 183-204.]
- POSSELT, HENRY J.
1898. Grønlands Brachiopoder og Bløddyr. Medd. Grønland, vol. 23, xix+298 pp., 2 pls.
- PRATT, HENRY SHERRING
1935. A manual of the common invertebrate animals (exclusive of insects). 854 pp., 974 figs. [Revised ed., originally published in 1916.]
- RAY, P. H.
1885. Report on the International Polar Expedition to Point Barrow, Alaska, 1881-83. 695 pp., 23 pls., 2 maps.
- REEVE, LOVELL
- 1843-1878. Conehologia Iconica, or figures and descriptions of the shells of mollusks. 20 vols., illus.
1855. Account of the shells collected by Captain Sir Edward Belcher, C. B., north of Beechey Island. In Belcher, The last of the Arctic voyages. Vol. 2, pp. 392-399, pls. 32, 33. (See Belcher, 1855.)
- REHDER, HARALD A.
1937. Notes on the nomenclature of the Trochidae. Proc. Biol. Soc. Washington, vol. 50, pp. 115-116.
- RINK, H. J.
1857. Grønland, geographisk og statistisk beskrevet. Vol. 2, Naturhistoriske Bidrag til en Beskrivelse af Grønland. 172 pp.
1877. Danish Greenland. xvii+468 pp., 16 pls., 1 map.
- ROSS, SIR JOHN
1819. A voyage of discovery . . . in His Majesty's ships *Isabella* and *Alexander* [in 1818] for the purpose of exploring Baffin's Bay and inquiring into the probability of a north-west passage. xxxix+252 (cxliv) pp., 29 col. pls., 3 maps, text illus.
- SARS, G. O.
1878. Bidrag til Kundskaben om Norges Arktiske Fauna. I. Mollusca regionis arcticae Norvegiae. xiii [iii]+466 pp., pls. 1-34 and i-xviii, 1 map.
- SARS, M.
1851. Beretning om en i Sommeren 1849 foretagen zoologisk Reise i Lofoten og Finmarken. Nyt Mag. Naturv., vol. 6, Heft 2, No. 10, pp. 121-211.
1859. Bidrag til en Skildring af den arktiske Molluskfauna ved Norges nordlige Kist. Forhandl. Vidensk. Selsk., pp. 34-87.
1869. Fortsatte bemaerkninger over det dyriske livs utbredning i havets dybder. Forhandl. Vidensk. Selsk., pp. 246-275.
- SASAKI, MADOKA
1920. Report of cephalopods collected during 1906 by the United States Bureau of Fisheries Steamer *Albatross* in the northwestern Pacific. Proc. U. S. Nat. Mus., vol. 57, pp. 163-203, pls. 23-26.

1929. A monograph of the dibranchiate cephalopods of the Japanese and adjacent waters. Journ. Coll. Agr. Hokkaido Imper. Univ., vol. 20 (supplementary number), v+357 pp., 159 figs., 30 pls.
- SCHLESCH, HANS
1931. Kleine Mitteilungen. VII. Beitrag zur Kenntnis der marinen Mollusken-Fauna Islands. Arch. Moll., vol. 63, pp. 133-155, pls. 1-16.
- SCHRENCK, LEOPOLD VON
1861. Vorläufige diagnosen einiger neuer Molluskenarten aus der Meerenge der Tartarei und dem nordjapanischen Meere. Bull. Acad. Imper. Sci. St. Petersburg, vol. 4, columns 408-413. [The entire volume was published in 1862, but the part containing Schrenck's article came out in 1861.]
- SCHUMACHER, H. C. F.
1817. Essai d'un nouveau système des habitations des Vers testaces. iv+287 pp., 22 pls.
- SHERBORN, CAROLO DAVIES
1902. Index animalium, 1758-1800. lix+1195 pp.
1932. Index animalium, 1801-1850. 10 vols.
- SMITH, JAMES
1839. On the last changes in the relative levels of the land and sea in the British Islands. Mem. Wernerian Nat. Hist. Soc. Edinburgh, vol. 8, pt. 1, pp. 49-113, pls. 1, 2; 3 text figs.
- SOOT-RYEN, TRON
1932. Pelecypoda, with a discussion of possible migrations of Arctic pelecypods in Tertiary times. The Norwegian North Polar Expedition with the *Maud* 1918-1925, Scientific Results, vol. 5, No. 12, pp. 1-35, pls. 1, 2.
1939. Some pelecypods from Franz Josef Land, Victoriaøya and Hopen collected on the Norwegian Scientific Expedition 1930. Det Kongelige Departement for Handel, Sjøfart, Industri, Handverk og Fiskeri. 21 pp., 1 pl.
1941. Northern pelecypods in the collection of Tromsø Museum. I. Order Anomalodesmacea; families Pholadomyidae, Thraciidae and Periplomatidae. Aarsh. Tromsø Mus., vol. 61, No. 1, 41 pp., 10 pls.
1951. New records on the distribution of marine Mollusca in northern Norway. Astarte, No. 1, 11 pp.
- SOWERBY, GEORGE B. (first of the name)
1825. A catalogue of the shells contained in the collection of the late Earl of Tankerville. Pp. vii, 1-92, xxxiv, 8 col. pls.
- SOWERBY, GEORGE B. (second of the name)
1841. Conchological illustrations. 200 col. pls.
1842-[1887]. Thesaurus conchyliorum, or monographs of genera of shells. 5 vols., col. illus.
- STEARNS, ROBERT E. C.
1871. Preliminary descriptions of new species of marine Mollusca from the west coast of North America. Conchological Memoranda, No. 7, pp. 1, 2.
- STEENSTRUP, JOHANNES JAPETUS SMITH
1881. Professor A. E. Verrill's to nye Cephalopodslægter: *Stenoteuthis* og *Lestoteuthis*. Bemaerkninger og Berigtigelser. Ofvers Kongl. Danske Vidensk. Selsk. Forh., pp. 1-27, text figs., pl. 1.

STIMPSON, WILLIAM

1851. Shells of New England. A review of the synonymy of the testaceous mollusks of New England, with notes on their structure, and their geographical and bathymetrical distribution . . . 56 pp., 2 pls.
1865. Review of the northern Buccinums, and remarks on some other northern mollusks. Pt. 1. Canadian Nat., vol. 2, No. 5, pp. 364-389.

STRØM, HANS

1768. Beskrivelse over norske insecter. Pt. 2, *Buccinum*. Kongl. Norske Vidensk. Selsk. Skrift., vol. 4, pp. 369-370, pl. 16.
1788. Beskrivelse over norske insecter. Pt. 5, new ser., Kongl. Danske Vidensk. Skrift., vol. 3, pp. 296-297, pl. 1.

THIELE, JOHANNES

- 1929-1935. Handbuch der systematischen Weichtierkunde. 4 vols., 1154 pp.

THORSON, GUNNAR

- 1935a. Studies on the egg-capsules and development of Arctic marine prosobranchs. Medd. Grønland, vol. 100, No. 5, pp. 1-71, figs. 1-75.
- 1935b. Biologische Studien über die Lamellibranchier *Modiolaria discors* L. und *Modiolaria nigra* Gray in Ostgrønland. Zool. Anz., vol. 111, Heft 11-12, pp. 297-304.
1944. The zoology of east Greenland. Marine Gastropoda Prosobranchiata. Medd. Grønland, vol. 121, No. 13, pp. 1-181, figs. 1-26.
1946. Reproduction and larval development of Danish marine bottom invertebrates. . . . Medd. fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Plankton, vol. 4, No. 1, pp. 1-523, figs. 1-198.

TORRELL, OTTO MARTIN

1859. Bidrag till Spitsbergens Mollusk-fauna. Jemte en allmän öfversigt af Arktiska regionens naturförhallanden och forntida utbredning. I. Akademisk afhandling. . . . , 154 pp., 2 pls.

TRYON, GEORGE W., AND PILSBRY, HENRY A.

- 1879-1898. Manual of conchology. 17 vols.

TURTON, W.

1834. Description of some new and rare British species of shells. Mag. Nat. Hist., vol. 7, pp. 350-353.

VERRILL, A. E.

1873. Report on the invertebrate animals of Vineyard Sound and adjacent waters. Mollusca. Moll. Rep. U. S. Fish Comm., vol. 1, pp. 634-698, pls. 20-32.
1881. The cephalopods of the northeast coast of America. Pt. 2. The smaller cephalopods, including the squids and the octopi, with other allied forms. Trans. Connecticut Acad. Arts Sci., vol. 5, pp. 259-446, pls. 24-56.
1884. Second catalogue of Mollusca recently added to the fauna of the New England coast and the adjacent parts of the Atlantic Trans. Connecticut Acad. Sci., vol. 6 (1882-85), art. 6, pp. 139-294, pls. 28-32.

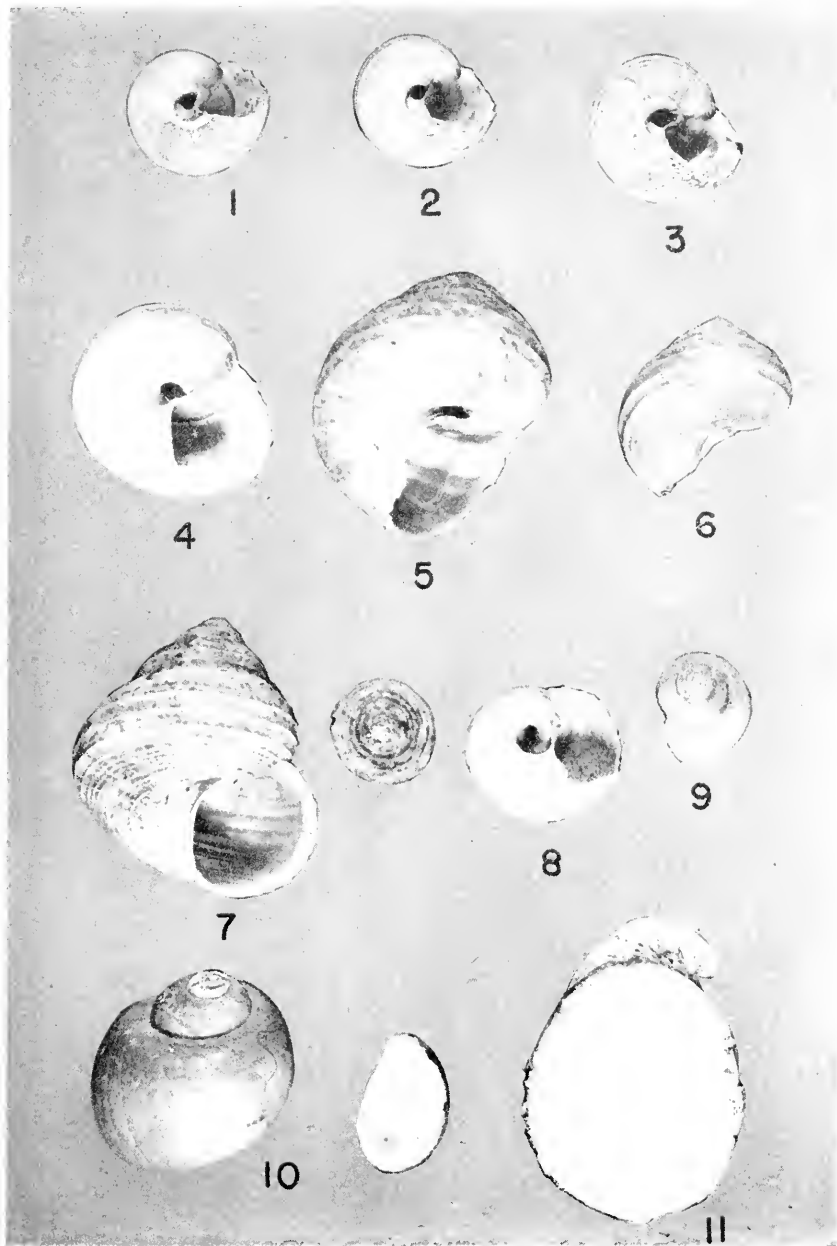
WOOD, WILLIAM

1828. Index testaceologicus, or a catalogue of shells. 212 pp., 38 col. pls. Supplement, 1828, pp. 1-59, pls. 1-8. [Originally published in 1818; there was also an edition in 1825.]

PLATES 1-27

EXPLANATION OF PLATE 1

- FIG. 1.—*Margarites costalis* var. *grandis* Mörch from 341 feet, showing flattened base and almost complete absence of basal lirae.
- FIGS. 2, 3.—Varieties of *Margarites costalis* (Gould) from 341 feet, showing flattened base: 2, with weak basal lirae, central ones very faint; 3, with strong basal lirae throughout.
- FIGS. 4-7.—Varieties of *Margarites costalis* (Gould): 4, from 453 feet, with somewhat rounded base and weak basal lirae; 5, forma *multilirata* ? Odhner from 341 feet, with strongly rounded base and very faint basal lirae; 6, from 341 feet, with somewhat rounded base and strong basal lirae; 7, shown with its operculum, from 741 feet, base strongly rounded, strong basal lirae, and a few faint intercalary threads between primary lirae of body whorl.
- FIG. 8.—*Margarites avenosooki*, new species. Paratype (Stanford Univ. Paleo. Type Coll. No. 8331) from 420 feet, showing flared umbilical opening.
- FIG. 9.—*Solariella obscura* (Couthouy) from 132 feet, apical view.
- FIG. 10.—*Natica clausa* Broderip and Sowerby from 420 feet (shown with its operculum).
- FIG. 11.—*Crepidula grandis* Middendorff from 130 feet (Sept. 15, 1948), showing strongly curved apex and heavy periostracum.
- MAGNIFICATION: All $\times 17.7$.

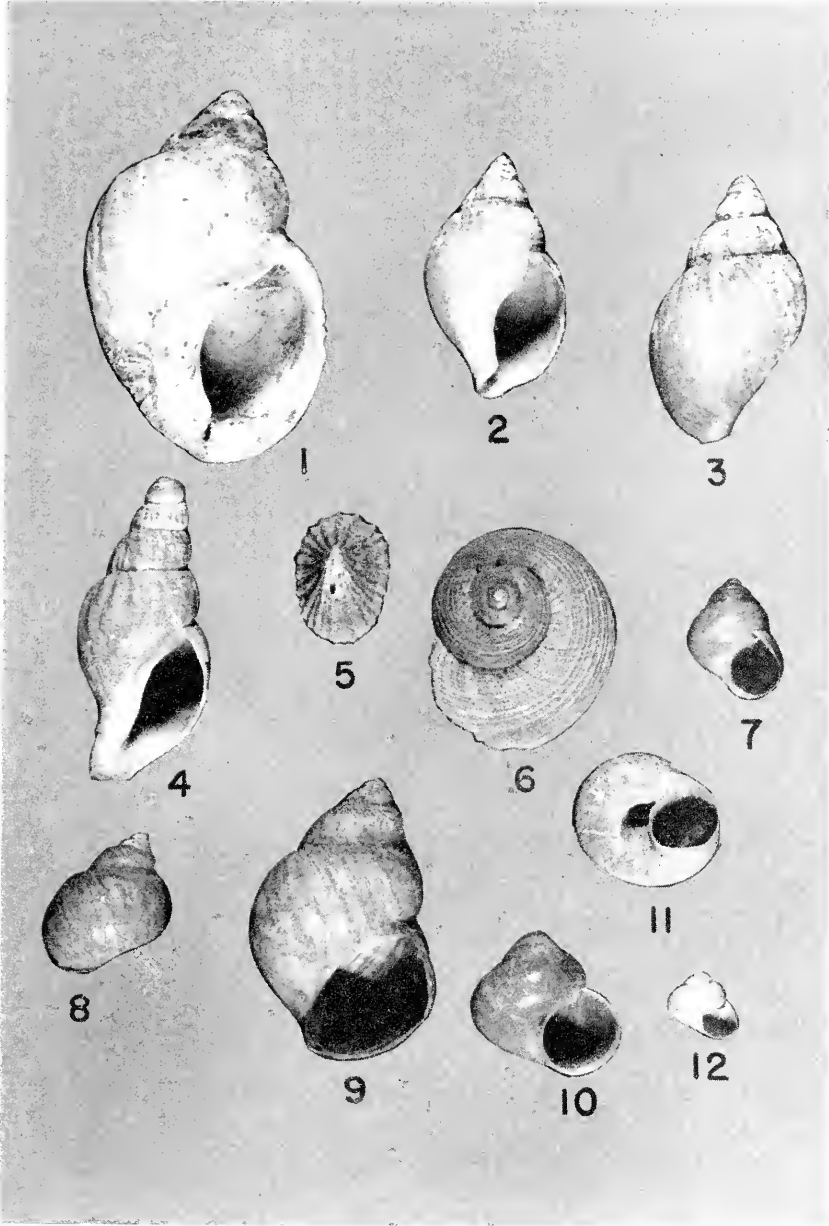


Trochidae, Naticidae, and Crepidulidae. Explanation on facing page.

EXPLANATION OF PLATE 2

- FIG. 1. *Admete couthouyi* var. *middendorffiana* Dall from 80 feet, showing tumidity, weak axial folds, and broad canal.
- FIGS. 2, 3. *Admete couthouyi* Jay, var., from 341 and 175 feet, respectively, showing more slender form, stronger axial folds and spiral sculpture, and narrower canal.
- FIG. 4. *Plicifusus troyeri* (Möller) from 341 feet, young specimen.
- FIG. 5. *Puncturella neachina* (Linnaeus) from 184 feet, apical view.
- FIG. 6. *Margarites avenasooki*, new species, from 420 feet, showing weak axial folds, fairly uniform spiral lirae, and absence of keel. (Paratype, Stanford Univ. Paleo. Type Coll. No. 8331.)
- FIG. 7. *Margarites frigidus* Dall from 420 feet.
- FIGS. 8, 9. *Aquilonaria turneri* Dall from 217 and 151 feet, respectively.
- FIG. 10. *Margaritopsis pribiloffensis* (Dall) from 741 feet.
- FIG. 11. *Solariella obscura* (Couthouy) from 132 feet, umbilical view.
- FIG. 12.— *Margaritopsis* ? *grosgenori* (Dall) from 175 feet.

MAGNIFICATION: All \times 2.7.



Cancellariidae, Neptunidae, Fissurellidae, Trochidae, and Lucinidae. Explanation of facing page.

EXPLANATION OF PLATE 3

FIG. 1. *Dendronotus prondosus* (Ascanius), washed ashore in September 1949.

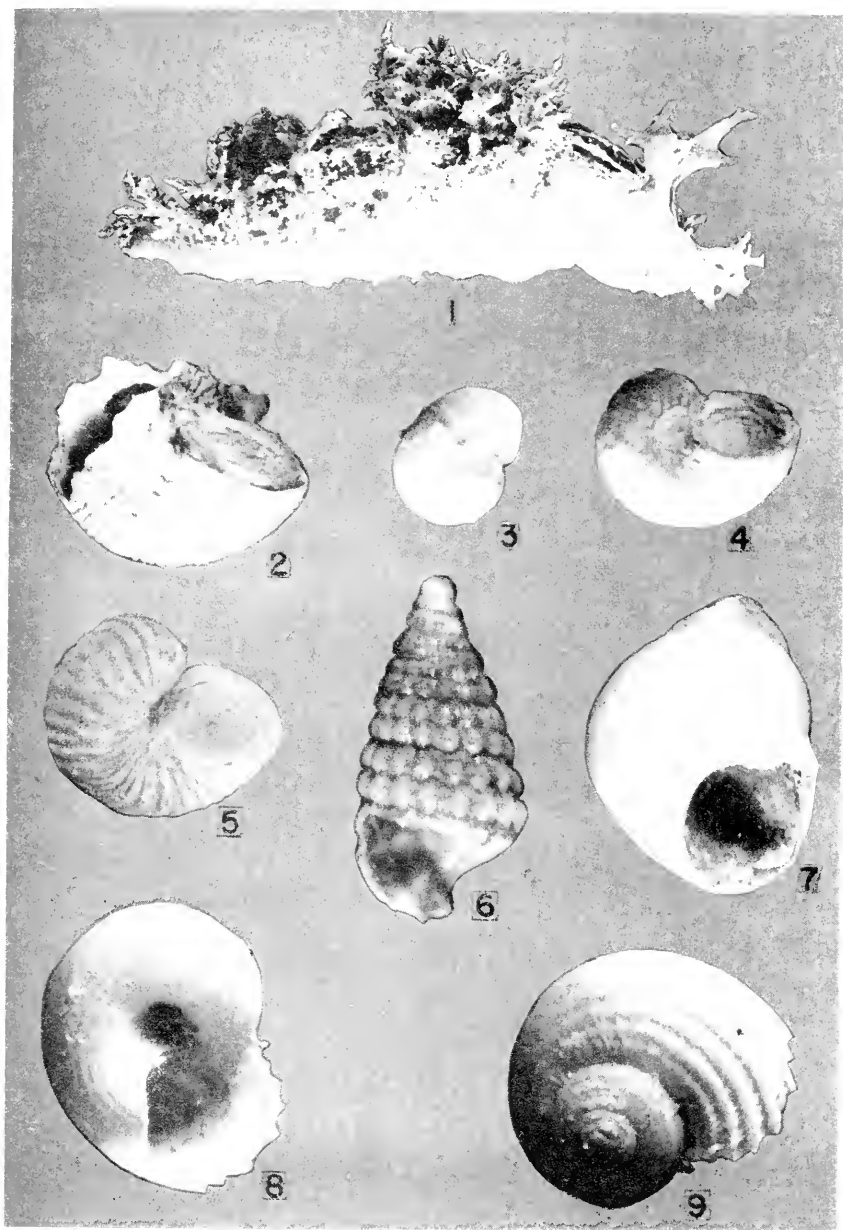
FIGS. 2-5. *Molleria costulata* (Möller): 2, from 741 feet, showing a form with many fine ribs interrupted by a prominent carina that outlines the umbilicus; 3, 4, from 453 and 477 feet, respectively, forms in which the axial sculpture consists almost entirely of incremental lines but with widely spaced evanescent axial riblets posterior to the carina outlining the umbilicus; shallow depressions between the riblets; 5, from 453 feet, showing a form with fewer and much coarser ribs than in 2; ribs uninterrupted because of no carina outlining the umbilicus.

FIG. 6. *Triphora perversa* (Linnaeus) from 341 feet, an immature specimen.

FIG. 7. *Margarites frigidus* Dall from 420 feet.

FIGS. 8, 9. *Margarites acenosooki*, new species, from 341 feet: 8, umbilical view, showing rounded shoulder and steplike cords on the base; 9, apical view.

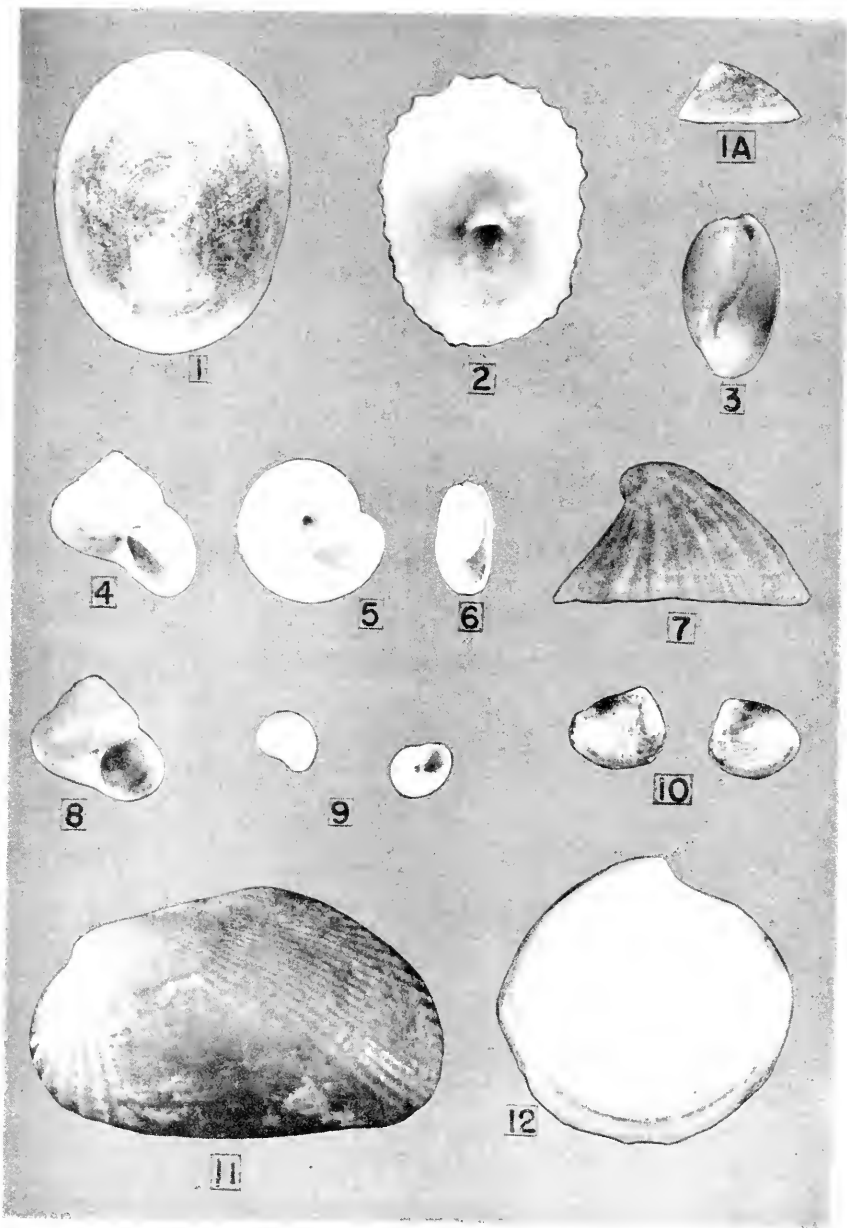
MAGNIFICATION: 1, $\times .86$; 2-5 $\times 16.7$; 6, $\times 18.6$; 7, $\times 6.5$; 8, 9, $\times 13.6$.



Dendronotidae, Liotiidae, Triphoridae, and Trochidae. Explanation on facing page.

EXPLANATION OF PLATE 4

- FIGS. 1, 1A. *Lepeta caeca* (Müller) from 132 feet: 1, apical view; 2, side view, showing straight anterior and convex posterior ends.
- FIGS. 2, 7.—*Puncturella noachina* (Linnaeus) from 184 feet: 2, interior view, showing props at sides of septum and depressions in front of them; 7, side view, showing straight anterior and convex posterior ends.
- FIG. 3. *Cylichna occulta* (Mighels) from plankton tow near shore (net touching bottom), July 13, 1950.
- FIGS. 4, 5. *Margaritopsis* ? *grosvenori* (Dall) from 175 feet.
- FIG. 6. *Retusa umbilicata* (Montagu) from 477 feet, a specimen without an umbilical perforation.
- FIGS. 8, 9. *Margarites vahli* Möller: 8, from 477 feet; 9, from 184 feet.
- FIG. 10.—*Myxella sovaliki*, new species, from 741 feet, left and right valve, respectively.
- FIG. 11.—*Musculus corrugatus* (Stimpson) from 204 feet, a young specimen 7.5 mm. long.
- FIG. 12.—*Thyasira flexuosa* (Montagu) var. *sarsi* Philippi from 162 feet.
- MAGNIFICATION: 1, × 4; 1A, × 1.6; 2, 3, × 5.5; 4-6, 10, × 5.4; 7-9, × 5.3; 11, × 7.5; 12, × 6.4.



Lepetidae, Pectonellidae, Scaphandridae, Trochidae, Aetacnidae, Leronidae, Mytilidae, and Thyasiridae. Explanation on facing page.

EXPLANATION OF PLATE 5

FIG. 1. *Admete regina* Dall from 522 feet.

FIGS. 2, 3. *Epitonium greenlandicum* (Perry): 2, from 152 feet; 3, from 216 feet, shown with its operculum.

FIGS. 4-6. *Piliscus commodus* (Middendorff). 4, from 125 feet, external view. 5, from 125 feet, showing all white interior. 6, from 175 feet, internal view of specimen with radiating reddish stripes.

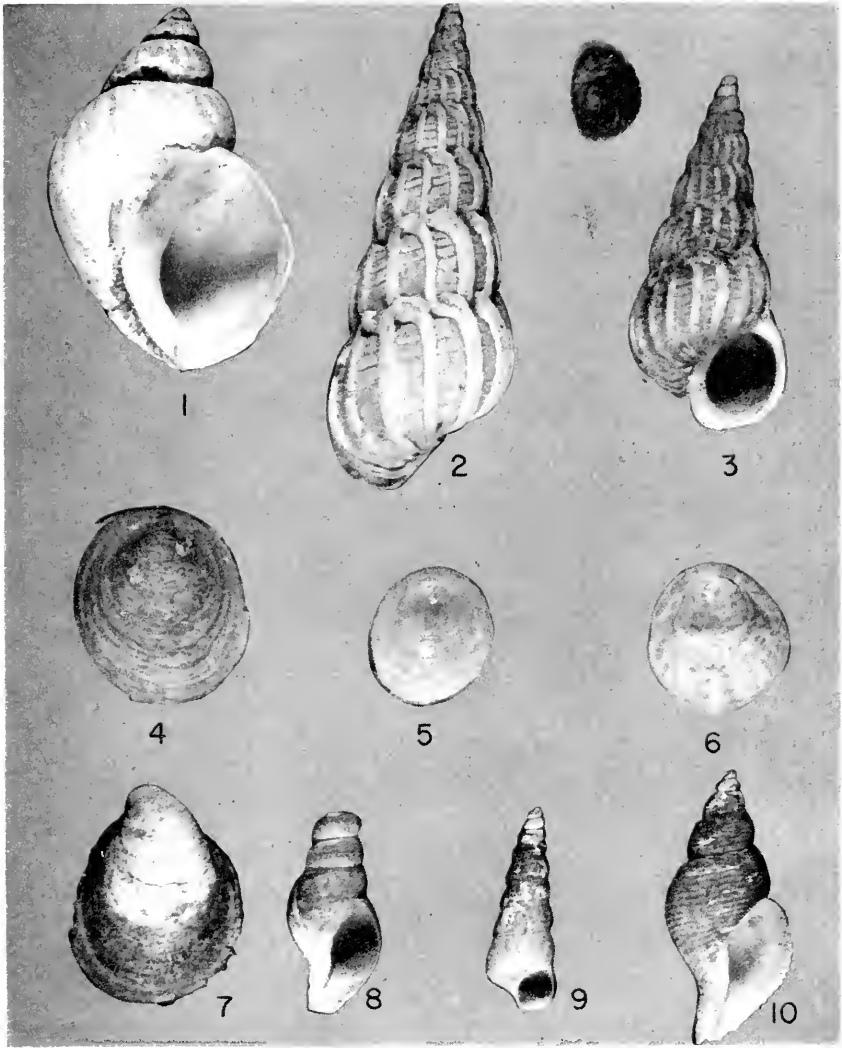
FIG. 7.- *Crepidula grandis* Middendorff from 217 feet, showing strongly curved apex.

FIG. 8. *Beringius beringi* (Middendorff) from 152 feet, a specimen only recently escaped from the egg capsule (see pl. 12).

FIG. 9. *Tachyrhynchus reticulatum* (Mighels) from 438 feet.

FIG. 10. *Ptychotractus occidentalis* Stearns from 438 feet.

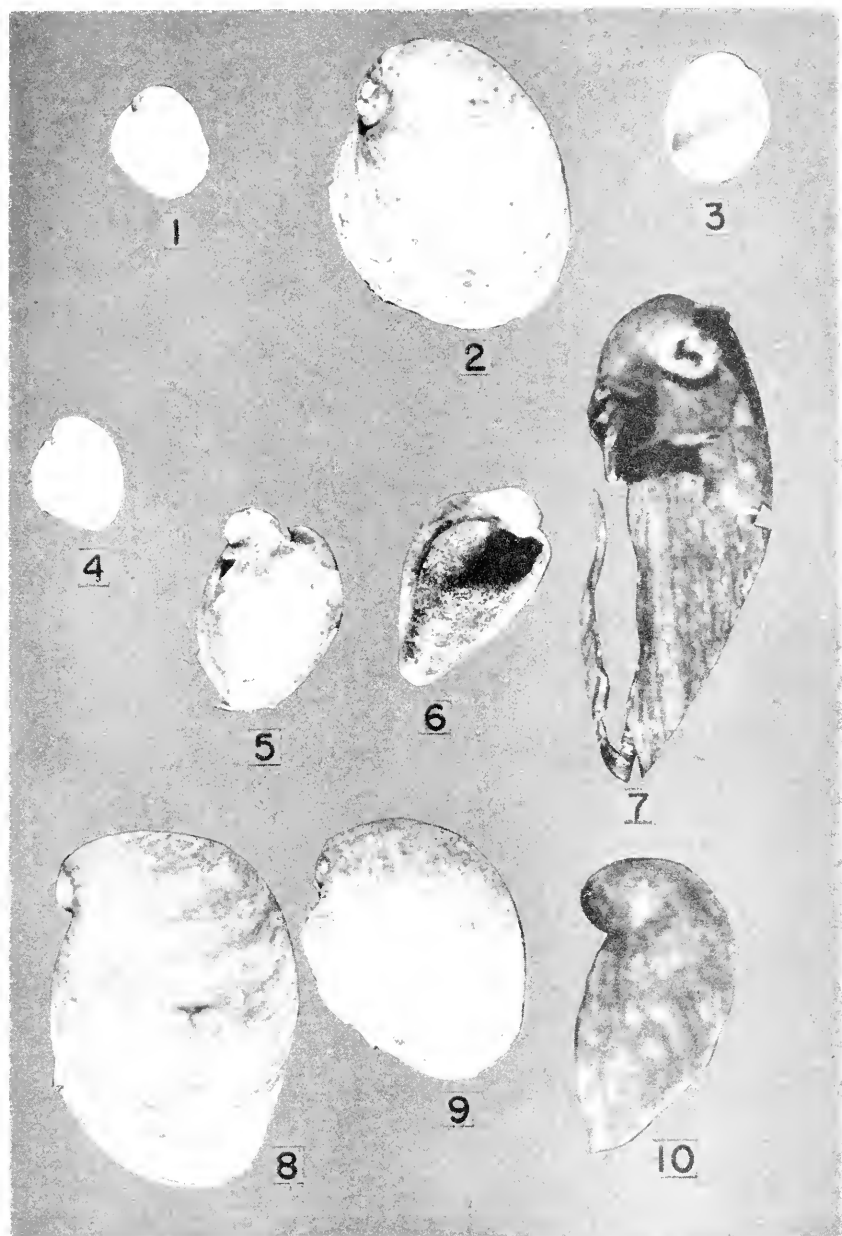
MAGNIFICATION: All 1.3.



Cancellariidae, Epitoniidae, Lamellariidae, Crepidulidae, Neptunidae, Turritellidae, and Fusinidae. Explanation on facing page.

EXPLANATION OF PLATE 6

- FIGS. 1-3. *Velutina undata* Brown from 204, 453, and 453 feet, respectively; all probably forma typica.
- FIG. 4. *Velutina velutina* (Müller) from 453 feet, showing the longitudinal cuticular ridges characteristic of this species.
- FIG. 5. *Velutina velutina* var. *schneideri* Fricke from 741 feet, showing the smoother cuticulum and evidence of a thin calcareous layer.
- FIG. 6. *Velutina plicatilis* (Müller) from 175 feet, view of interior.
- FIG. 7. *Velutina lanigera* (Möller) washed ashore Sept. 12, 1949.
- FIG. 8. *Velutina plicatilis* (Müller) washed ashore August 1948, view of exterior.
- FIGS. 9, 10. *Velutina plicatilis*, var. *cryptospira* Middendorff: 9, washed ashore Oct. 5, 1949; 10, washed ashore Aug. 21, 1949, showing sunken apex covered by cuticulum.
- MAGNIFICATION: All $\times 2$.



Lamellariidae. Explanation on facing page.

EXPLANATION OF PLATE 7

FIGS. 1, 2. *Boreotrophon clathratus* (Linnaeus): 1, from 110 feet (USNM 606203); 2, from 125 feet.

FIG. 3. *Boreotrophon clathratus* var. *scalariformis* Gould from 184 feet, showing the more prominent varices, which, because of chipping, always appear roughly crenulate.

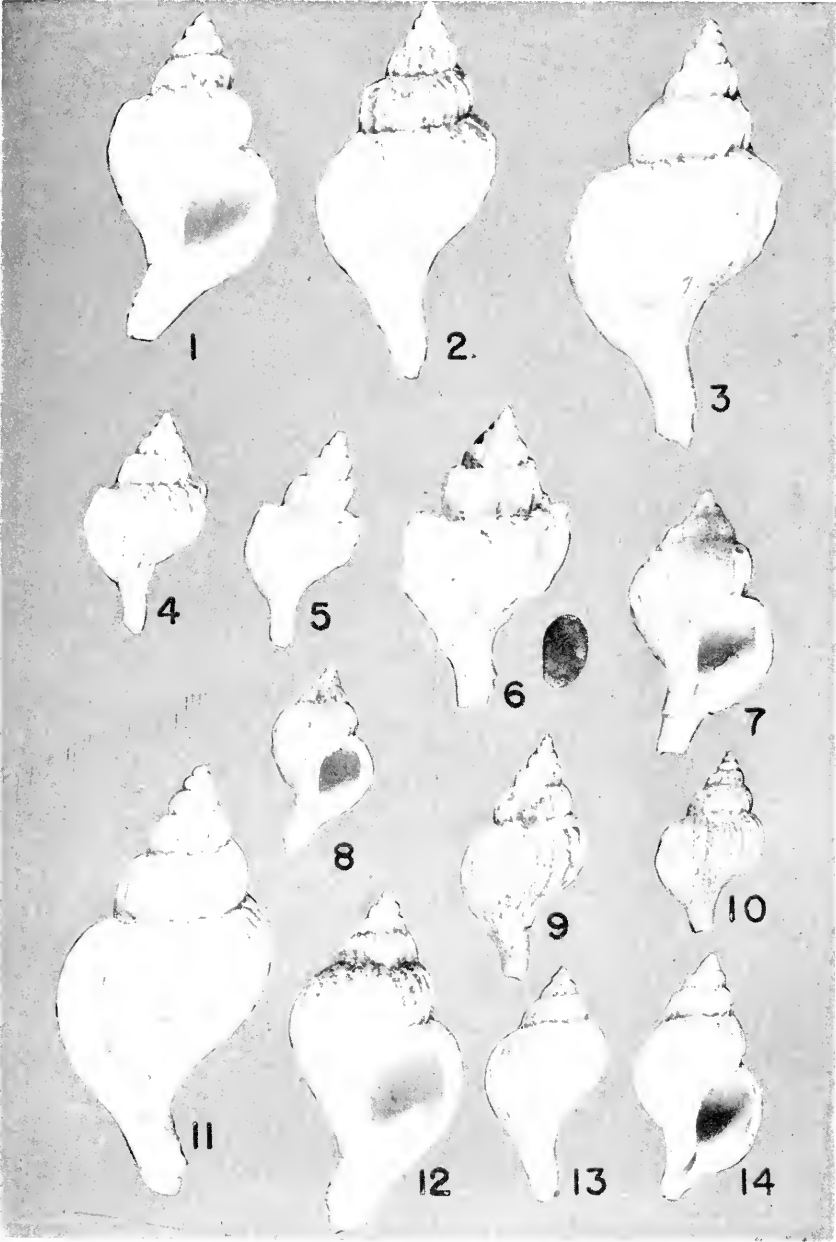
FIGS. 4-7. *Boreotrophon clathratus* var. *gunneri* Lovén: 4, from 453 feet; 5, from 152 feet; 6, from 741 feet (shown with its operculum); 7, from 125 feet. These specimens show a varying number of varices and varying degrees of angularity at the shoulder.

FIGS. 8-10. *Boreotrophon truncatus* (Strom), var.? from 125, 152, and 152 feet, respectively. Specimens shown in 8 and 9 have a longer canal than typical *truncatus*.

FIGS. 11, 12. *Boreotrophon heringi* (Dall): 11, washed ashore Sept. 20, 1949; 12, from 453 feet.

FIGS. 13, 14. *Boreotrophon pacificus* (Dall): 13, washed ashore Aug. 21, 1949; 14, from 132 feet.

MAGNIFICATION: All $\times 4.5$.



Murecidae. Explanation on facing page.

EXPLANATION OF PLATE 8

FIG. 1. *Margaritopsis pribilofensis* (Dall) from 741 feet.

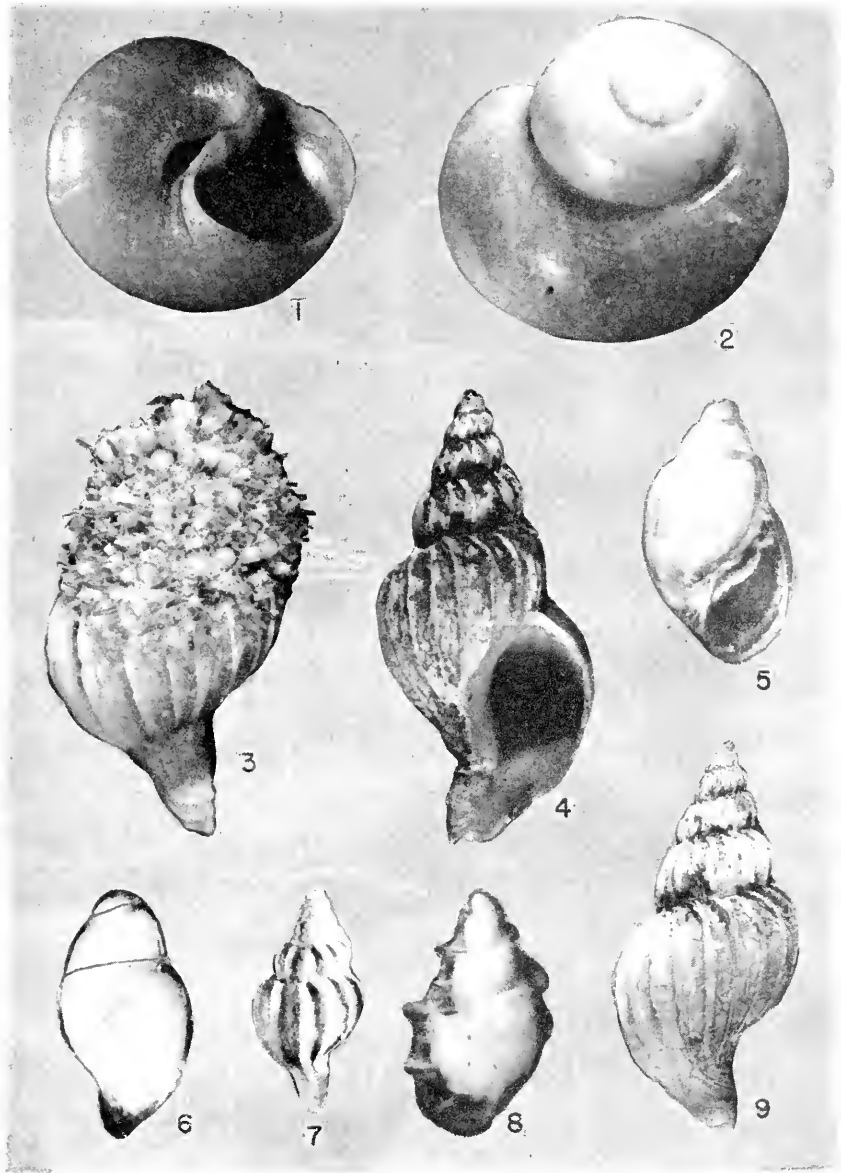
FIG. 2. *Margaritopsis*? *grosgenori* (Dall) from 175 feet, apical view, showing the fine spiral lirae and the deep sutures.

FIGS. 3, 4, 7, 9. *Boreotrophon truncatus* (Strom): 3, from 217 feet, aboral view of specimen in which the entire spire is covered with *Syncoryne* sp.; 4, 9, oral and aboral views of specimen from 741 feet; 7, aboral view of specimen from 120 feet (Sept. 15, 1948) from foliaceous bryozoan.

FIGS. 5, 6. *Odostomia cassandra* Dall and Bartsch: 5, oral view of adult from 140 feet; 6, aboral view of immature specimen from 453 feet.

FIG. 8. *Raphitoma amoena*? Sars from 184 feet, aboral view showing the spiral folds.

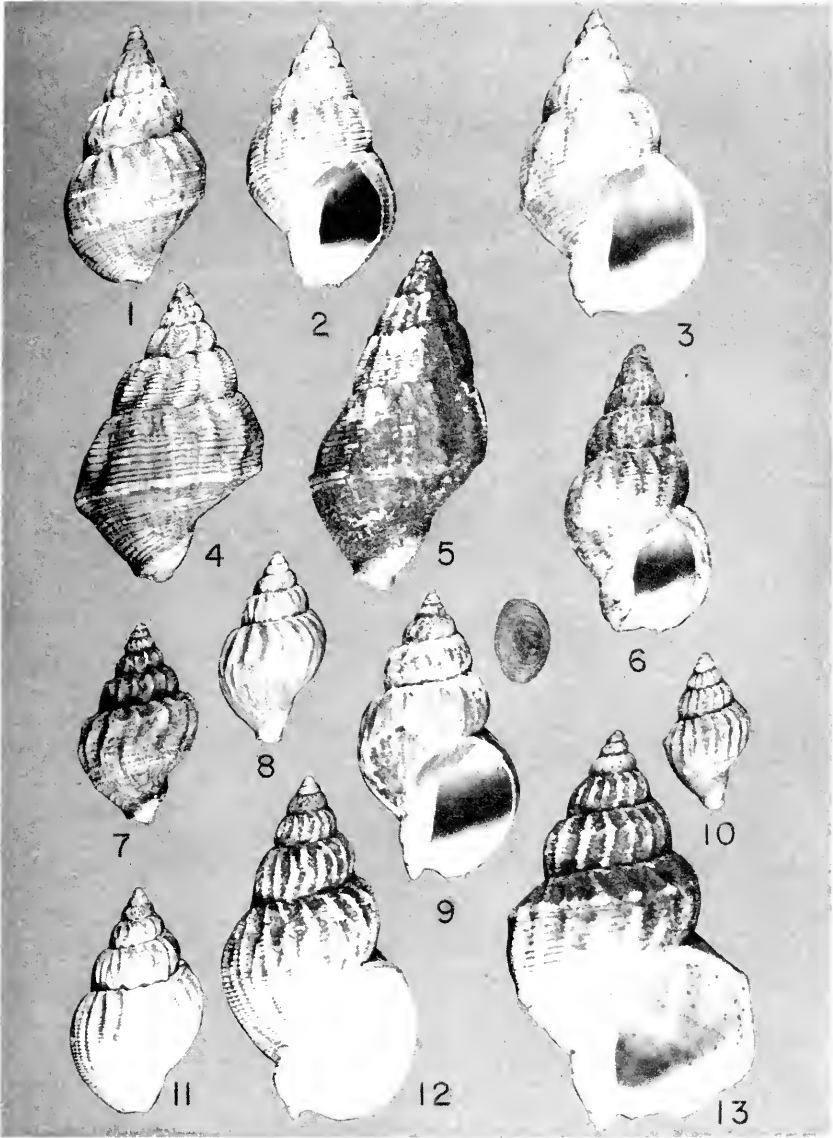
MAGNIFICATION: 1, $\times 5.6$; 2, $\times 13$; 3, $\times 5.3$; 4, $\times 3.5$; 5, $\times 12.5$; 6, $\times 22$; 7, $\times 4$; 8, $\times 11$; 9, $\times 3.1$.



Trochidae, Muricidae, and Pyramidellidae. Explanation on facing page.

EXPLANATION OF PLATE 9

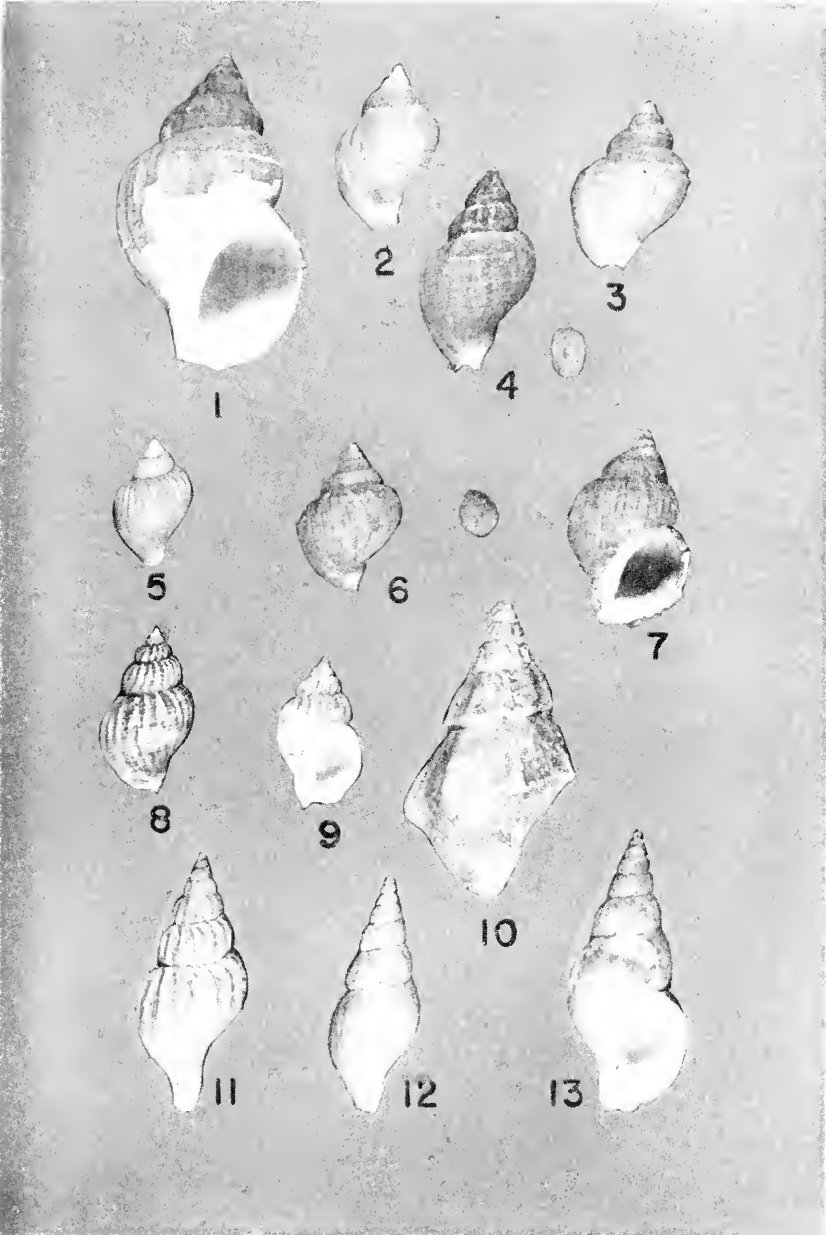
- FIGS. 1-6. *Buccinum glaciale* Linnaeus: 1, from 150 feet, showing characteristics close to those of typical *B. glaciale*; 2, from 522 feet, showing one faint carina, rounded shoulder, and fairly weak axial folds; 3, from 184 feet, showing stronger axial folds, one carina, a slight keel at the shoulder, and gradually expanding whorls; 4, from 125 feet, the most common form at Point Barrow, showing axial folds, one strong carina, a keel at the shoulder, a base flatter than in the preceding specimens, and more rapidly expanding whorls; 5, from 80 feet (Apr. 12, 1950), characterized by moderate axial folds, a long slender spire and flat whorls; 6, from 125 feet, characterized by a long, very slender spire, a short aperture, a mere suggestion of a carina, and rounded shoulder and base.
- FIGS. 7, 10, 13. *Buccinum glaciale* var. *morehianum* Dunker: 7, an immature specimen from 213 feet exhibiting a strong shoulder; 10, a young specimen from 522 feet showing a faint carina and a weak shoulder; 13, a mature specimen from 453 feet with 2 carinae on the body whorl and a moderate shoulder.
- FIGS. 8, 9. *Buccinum tenue* Gray: 8, from 80 feet (Apr. 18, 1950); 9, specimen with its operculum, from 110 feet (Sept. 8, 1948). The shells are usually much thinner and the spiral sculpturing much fainter than in *B. plectrum*; the interrupted nature of the axial fold gives them a wavy appearance.
- FIGS. 11, 12. *Buccinum plectrum* Stimpson: 11, from 125 feet; 12, from 522 feet. Typical specimens.
- MAGNIFICATION: All about same size.



Buccinidae. Explanation on facing page.

EXPLANATION OF PLATE 10

- FIG. 1. *Buccinum polare* var. *orotundum* Dall from 80 feet (Mar. 20, 1950), showing the tumid body whorl.
- FIGS. 2, 3. *Buccinum polare* Gray varieties from 64 feet (May 15 and May 17, 1950, respectively), showing variation in axial folds and spiral sculpture. (These may be immature specimens of var. *orotundum*.)
- FIG. 4. *Buccinum polare* Gray, with its operculum, from 64 feet (May 17, 1950), near the typical in form.
- FIG. 5. *Buccinum undatum* var. *striatum* Pennant from 477 feet.
- FIGS. 6, 7. *Buccinum fringillum* Dall from 453 feet.
- FIGS. 8, 9. *Buccinum ciliatum* Fabricius from 162 and 341 feet, respectively.
- FIG. 10. *Buccinum angulosum* Gray, typical form, a young adult from Eluitkak Pass (Aug. 10, 1948).
- FIGS. 11-13. *Plicifusus kroyeri* (Möller): 11, a typical *P. kroyeri* from 125 feet; 12, 13, slenderer forms, from 420 feet, with weak axial folds and microscopic spiral sculpture.
- MAGNIFICATION: All $\times .75$.



Buccinidae and Neptunidae. Explanation on facing page.

EXPLANATION OF PLATE II

FIGS. 1-3. *Buccinum angulosum* var. *normale* Dall: 1, a typical var. *normale*, from 37 feet (May 30, 1950), showing the smooth whorls with very weak axial folds only near the suture; 2, from 37 feet (May 17, 1950), showing slightly stronger axial folds; 3, from 37 feet (Mar. 10, 1950), showing a faint carina and, on the last whorl, axial ridges resulting from growth difficulties.

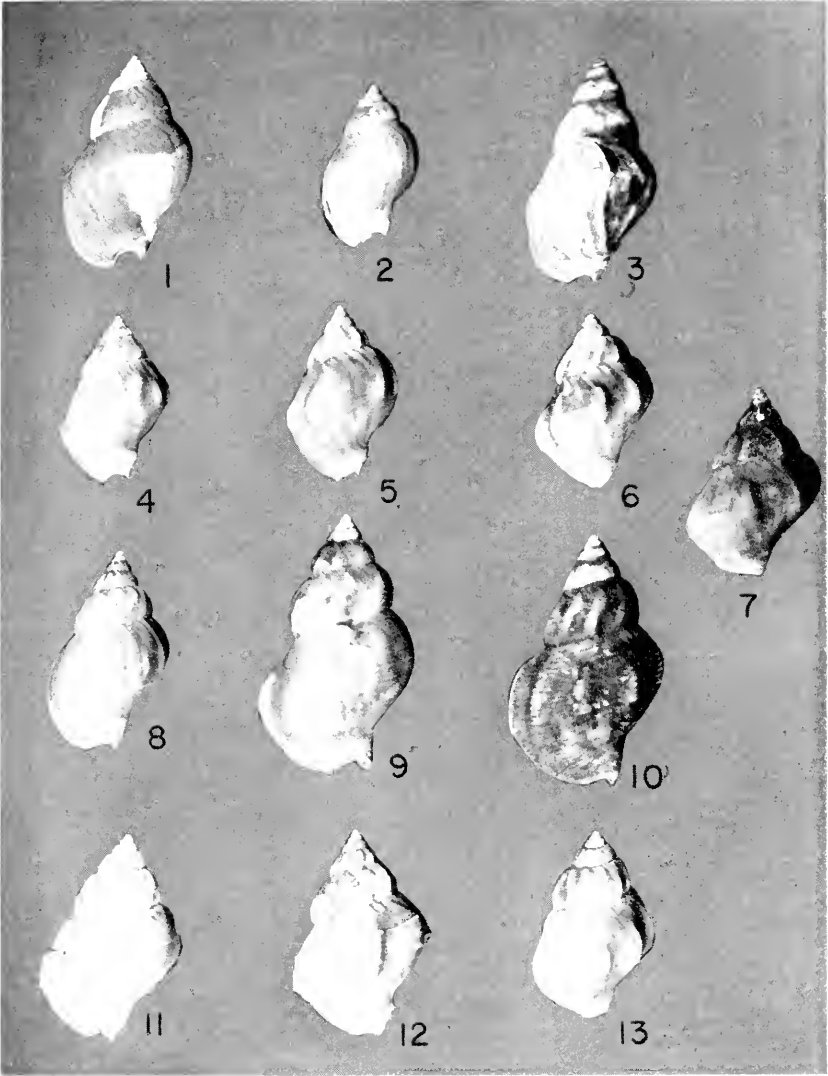
FIGS. 4-6.—*Buccinum angulosum* var. *subcostatum* Dall: 4, a specimen with somewhat less pronounced longitudinal ribs than typical; 5, a typical var. *subcostatum*; 6, a specimen with strong longitudinal ribs and with a faint spiral cord. All from 37 feet (May 17, 1950).

FIG. 7.—*Buccinum angulosum* Gray, a typical young adult from 64 feet (May 17, 1950). (For mature adult, see pl. 17, fig. 5.)

FIGS. 8-10. *Buccinum angulosum* varieties: 8, a specimen from 37 feet (May 17, 1950), showing characteristics of var. *normale* (fairly smooth body whorl), var. *subcostatum* (stronger axial folds than in var. *normale*), and var. *transliratum* (a spiral cord); 9, a specimen from 64 feet (May 17, 1950), showing less of the characteristics of var. *normale* and more of those of var. *subcostatum* and var. *transliratum* (stronger axial ribs, more and stronger spiral cords than in 8). 10, a specimen washed ashore (September 1949), strongly resembling var. *subcostatum* but with spiral cords suggestive of var. *transliratum*.

FIGS. 11-13.—*Buccinum angulosum* var. *transliratum* Dall: 11, a specimen from 37 feet (May 17, 1950) with three cords but with weak axial folds or ribs on last whorl; 12, a form from 37 feet (May 26, 1950), with strong axial ribs, two strong and one faint cord on the last whorl; 13, a form intermediate between var. *subcostatum* and var. *transliratum* washed ashore (September 1949).

MAGNIFICATION: All $\times 64$.



Buccinidae. Explanation on facing page.

EXPLANATION OF PLATE 12

FIGS. 1-5. — *Beringius beringi* (Middendorff): 1, from 455 feet, showing a heavy shell with long spire and relatively short aperture; 2, a juvenile, from 152 feet, just escaped from the capsule; 3, a thinner shell, from 40 feet (Eluítkak Pass, Aug. 10, 1948), with a short spire and long aperture, shown with its operculum in place. — 4, 5, young specimens, from 125 and 216 feet, respectively, showing variation in the nuclear whorls and aperture.

FIG. 6. — *Beringius beringi* var. *kobelti* Dall from 125 feet.

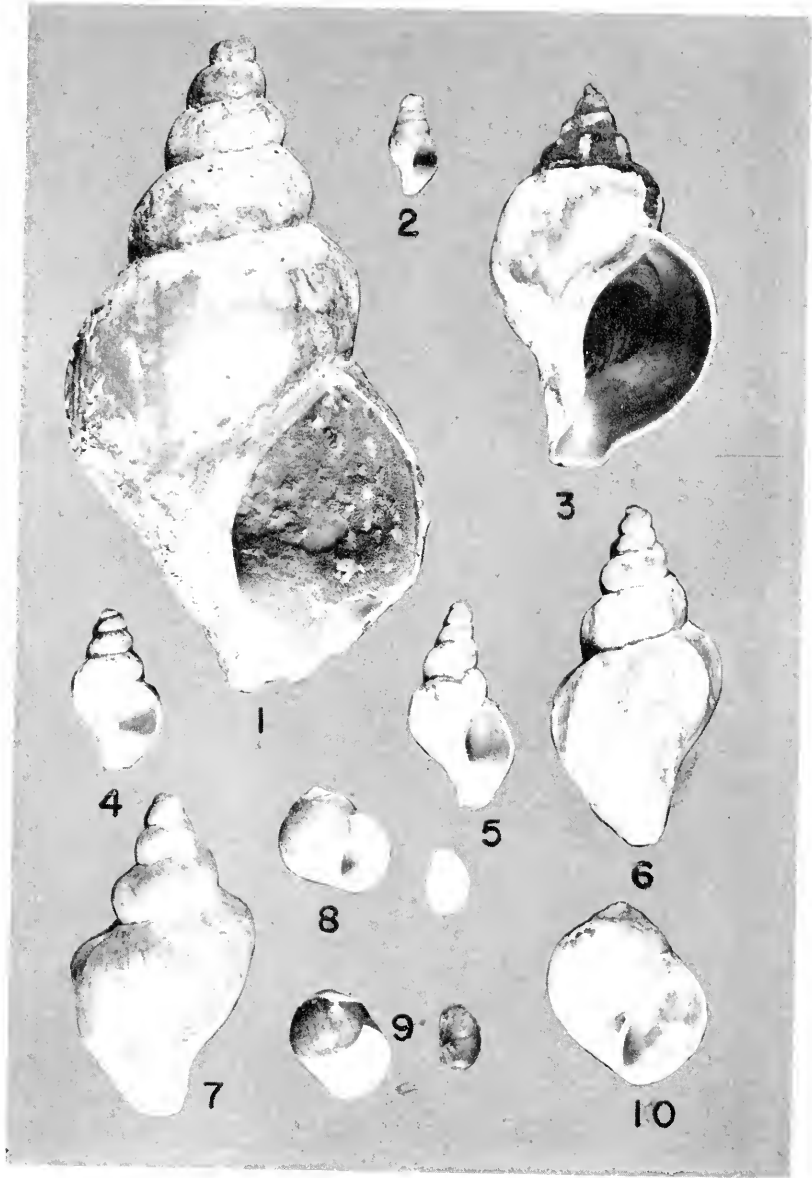
FIG. 7. — *Volutopsius stefanssoni* Dall from 110 feet (Sept. 8, 1948).

FIG. 8. — *Natica clausa* Broderip and Sowerby from Eluítkak Pass (Aug. 6, 1948), shown with its shelly operculum.

FIG. 9. — *Polinices monteronus* Dall from 295 feet, with its horny operculum, showing the notched callus covering the umbilicus, and the thickened pillar lip.

FIG. 10. — *Polinices pallidus* (Broderip and Sowerby) from 130 feet (Sept. 15, 1948).

MAGNIFICATION: All $\times .7$.



Neptunidae and Naricidae. Explanation on facing page.

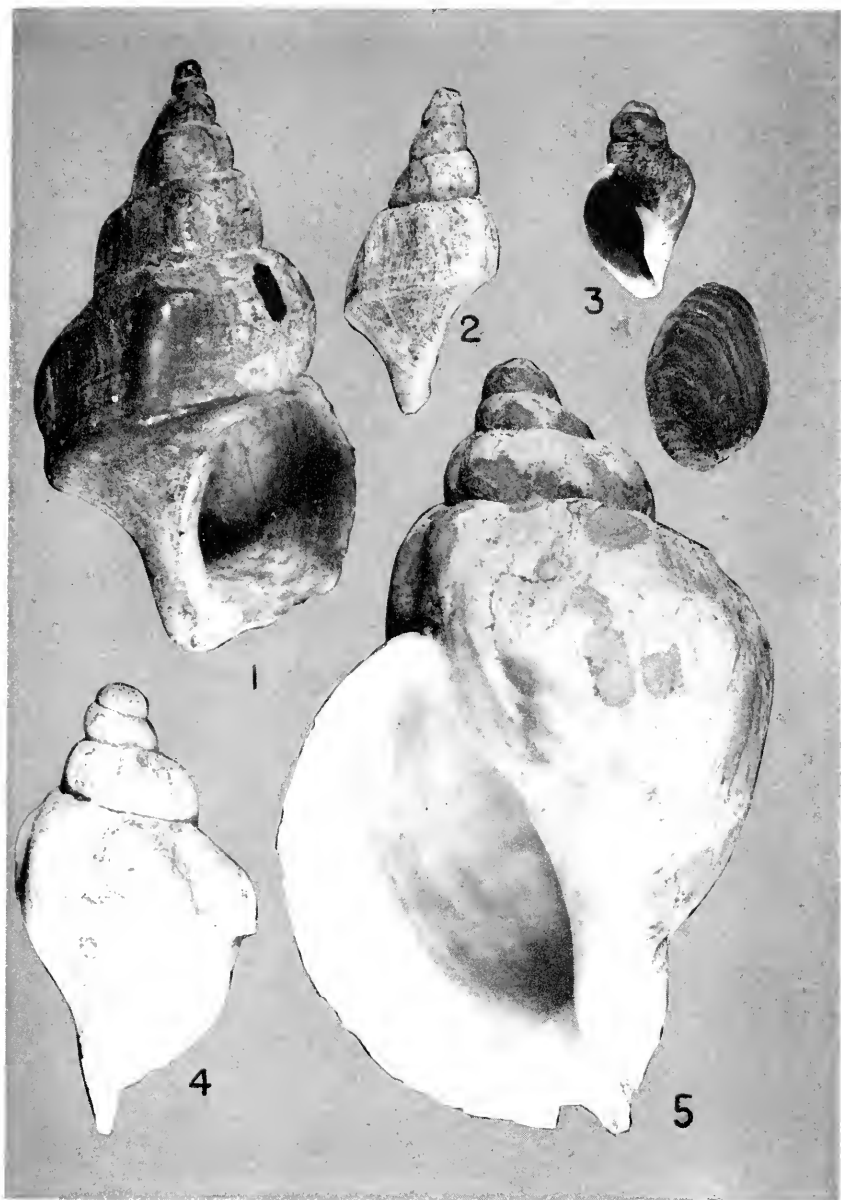
EXPLANATION OF PLATE 13

FIG. 1.—*Beringius stimpsoni* forma *malleatus* Dall from 125 feet, a specimen that is 4-sided in the last whorls.

FIG. 2.—*Beringius stimpsoni* (Gould) from 522 feet, a specimen that is 6-sided in the last whorl.

FIGS. 3-5.—*Pyrulofusus deformis* (Reeve) from 438, 120 (Sept. 15, 1948), and 130 feet (Sept. 15, 1948), respectively. The external lips of 4 and 5 are broken near the canal.

MAGNIFICATION: All $\times .71$.



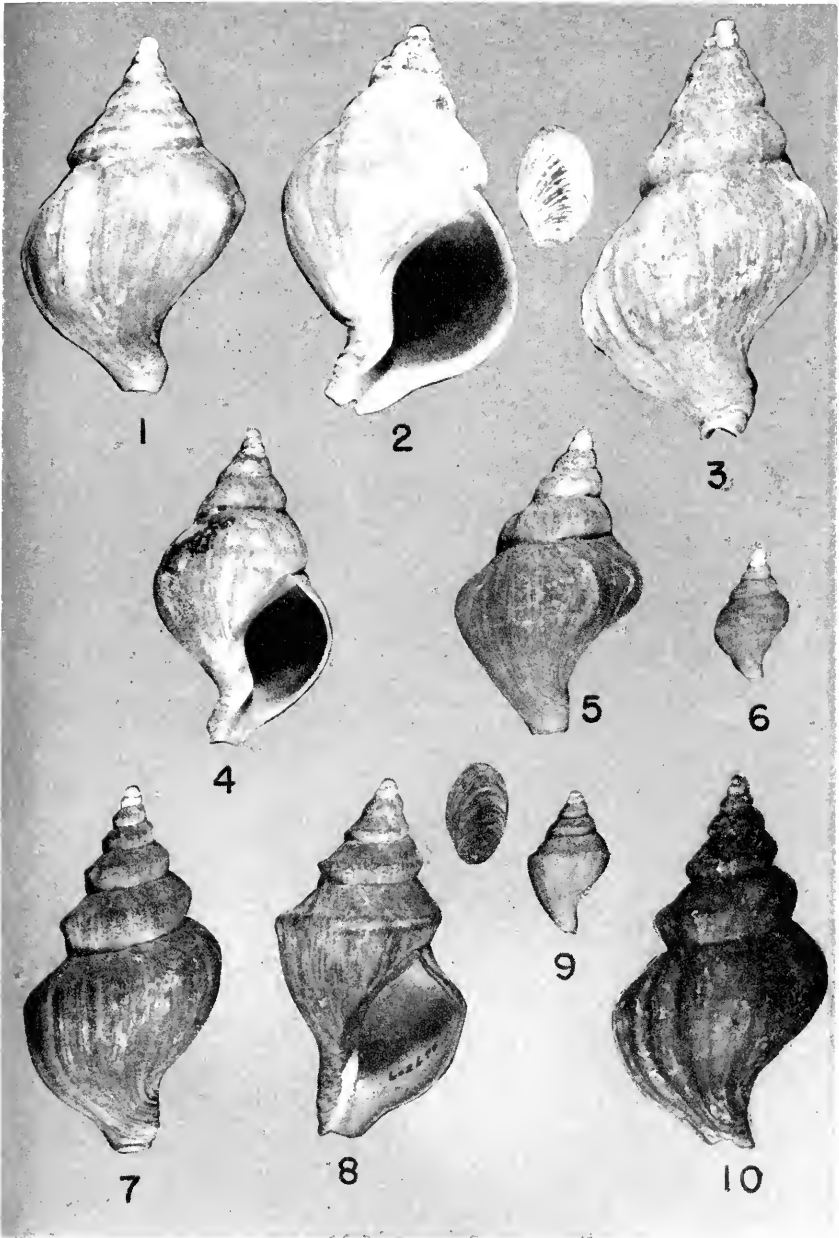
Neptunidae. Explanation on facing page.

EXPLANATION OF PLATE 14

FIGS. 1-6. *Neptunea ventricosa* (Gmelin): 1, a "ventricose" form from 120 feet (Sept. 15, 1948), with flat whorls, showing the two carinae and the cylindrical nucleus; 2, from 420 feet, shown with its operculum; 3, a long-spired form (USNM 606148) from 420 feet, with inconspicuous carinae and with lamellose projections on the last whorl; 4, a slender form (USNM 606150) from 453 feet; 5, a nodulous form (USNM 606149) from 341 feet, with evanescent carinae and more convex whorls; 6, a young specimen (USNM 606151) from 152 feet.

FIGS. 7-10. *Neptunea middendorffiana*, new name: 7, aboral view of paratype (USNM 606142) from 420 feet, a form in which the carina is nearer the posterior end of the whorl; 8, oral view of holotype (USNM 602694) from 175 feet, with the carina nearer the anterior end of the whorl (shown with its operculum); 9, young specimen (USNM 606132) from 120 feet (Aug. 8, 1949); 10, a nodulous specimen (USNM 602688) from 125 feet, with the carina in the middle of the whorls, and with near-lamellose ridges on the last whorl.

MAGNIFICATION: All $\times .75$.

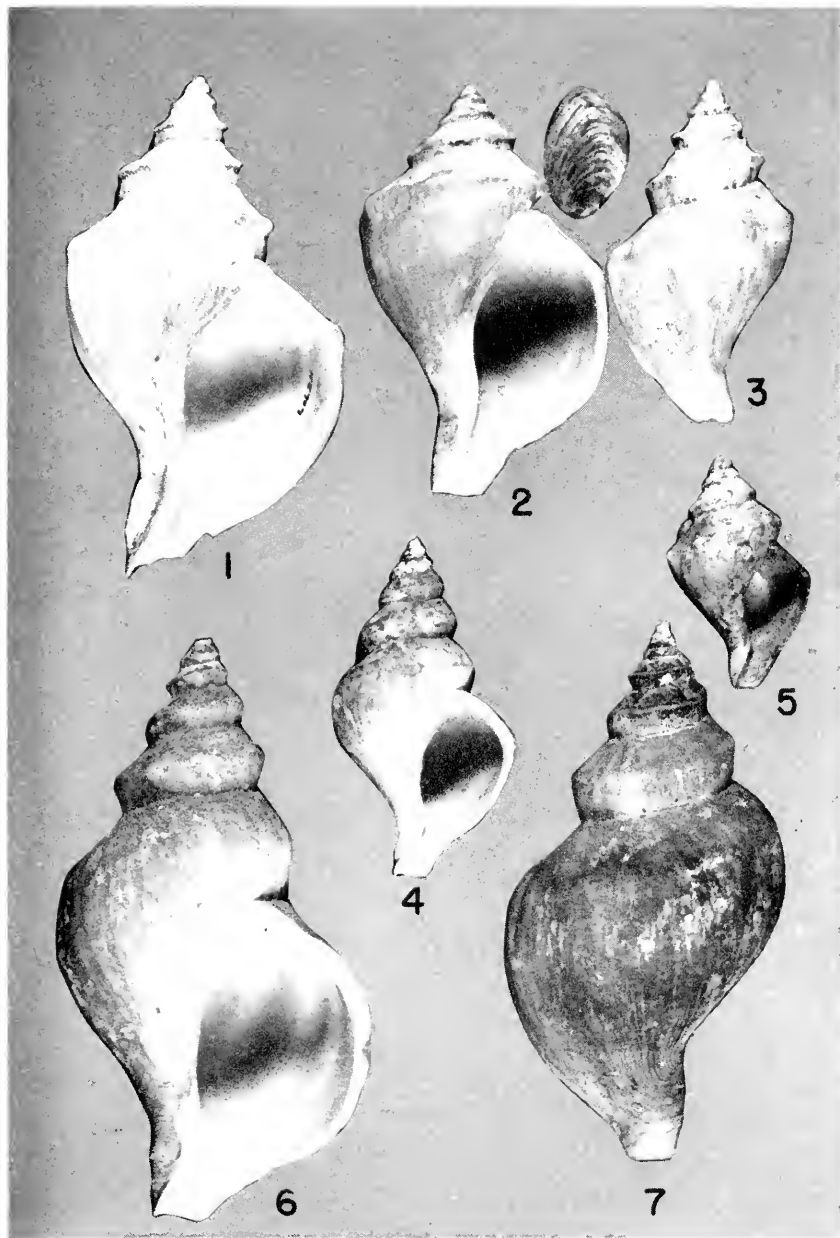


Neptunidae. Explanation on facing page.

EXPLANATION OF PLATE 15

FIGS. 1-7.--*Neptunea heros* Gray: 1, a shell from 40 feet (Eluitkak Pass, Aug. 10, 1948) with a long aperture and medium spire, a strong carina and weak nodules; 2, shell from same depth and locality with a long aperture and very short spire, a strong carina and elongated nodules (shown with its operculum); 3, shell (washed ashore) with a long aperture, a fairly long spire, a strong carina, and prominent nodules; 4, a very slender form from 522 feet with a long spire, an unusually weak carina, and scarcely perceptible nodules; 5, a young specimen from Eluitkak Pass, similar to No. 3; 6, a long-spired form from 522 feet with moderately developed carina and nodules, both of which are practically lacking in the last whorl; 7, shell from 741 feet, similar to No. 6, but with a shorter spire and weaker nodules.

MAGNIFICATION: All $\times .75$.



Neptunidae. Explanation on facing page.

EXPLANATION OF PLATE 16

FIG. 1. —*Obesotoma tenuilirata* (Dall) from 152 feet.

FIG. 2.—*Obesotoma simplex* (Middendorff) washed ashore Sept. 12, 1949.

FIG. 3. —*Oenopota nazanensis* (Dall) from 216 feet.

FIG. 4.—*Oenopota tenuicostata* (M. Sars) from 420 feet.

FIGS. 5, 6. —*Oenopota harpa* (Dall) from 420 and 110 feet (Sept. 16, 1948), respectively.

FIGS. 7, 8.—“*Oenopota*” *elegans* (Möller) from 152 and 204 feet, respectively.

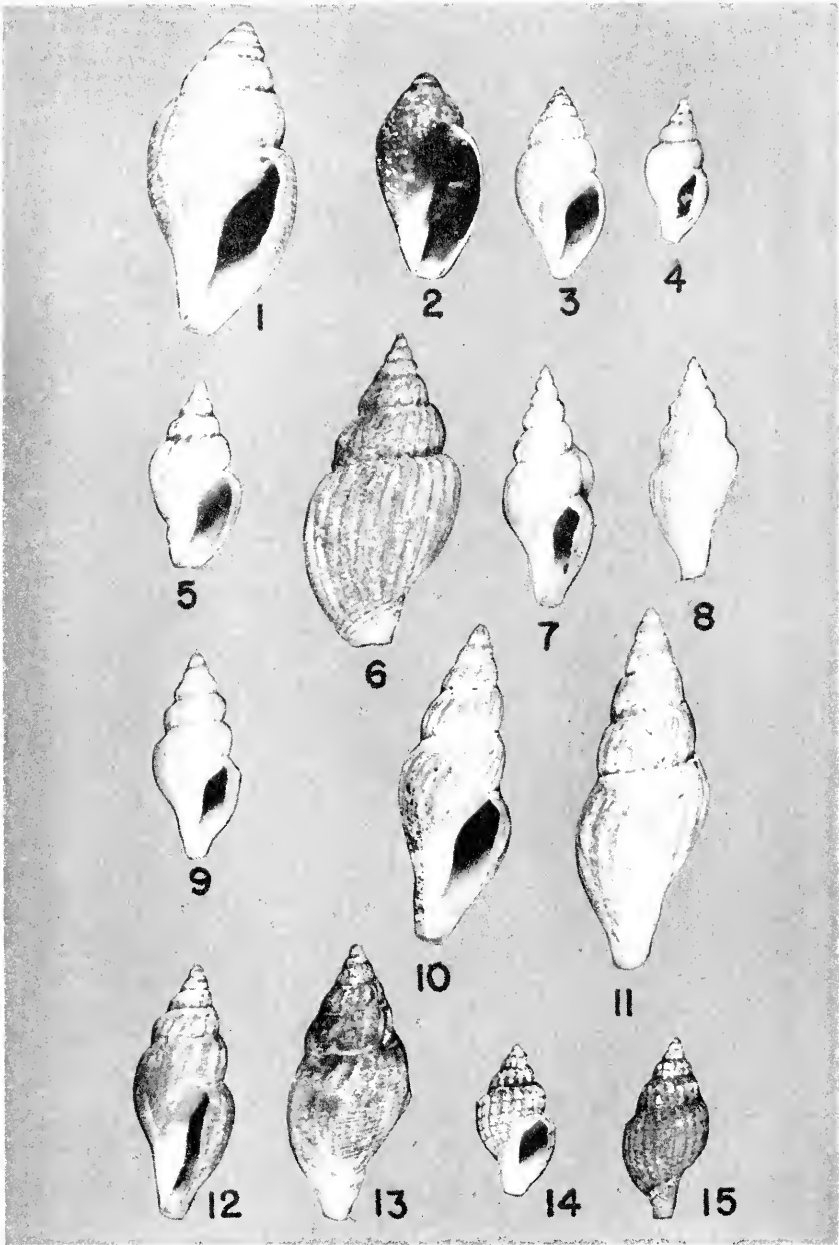
FIG. 9.—“*Oenopota*” *harpularia* (Couthouy) from 130 feet (Aug. 9, 1949).

FIGS. 10, 11. —“*Oenopota*” *pyramidalis* (Strom) from 453 and 295 feet, respectively.

FIGS. 12, 13. —“*Oenopota*” *pyramidalis* var. *semiplicata* G. Sars from 152 and 216 feet, respectively.

FIGS. 14, 15.—*Nodotoma impressa* (Mörch) from 295 and 477 feet, respectively.

MAGNIFICATION: All $\times 2.56$.



Turridae. Explanation on facing page.

EXPLANATION OF PLATE 17

FIGS. 1, 2.—*Symmetrogephyrus vestitus* (Broderip and Sowerby): 1, a specimen from 295 feet with many tufts of hairs; 2, a specimen from 522 feet with sparse tufts of hairs.

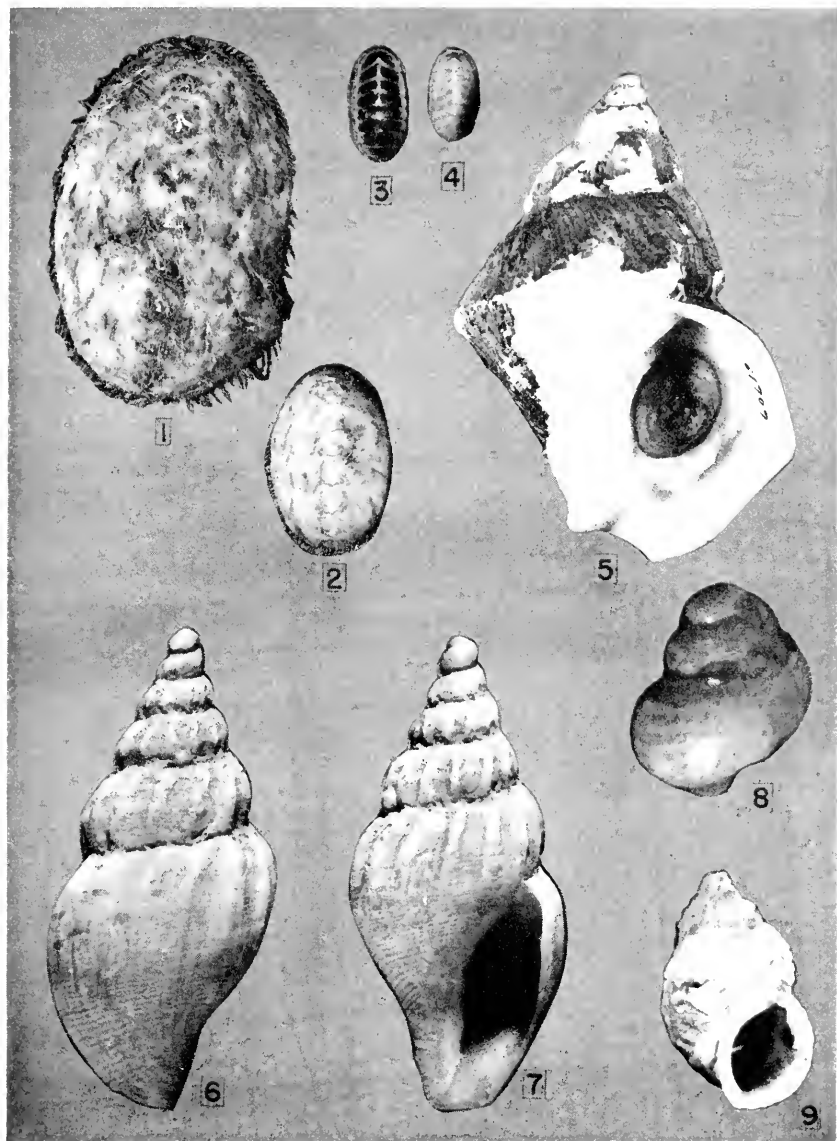
FIGS. 3, 4.—*Trachydermon albus* (Linnaeus), a dark and a light form, respectively, from 217 feet.

FIG. 5.—*Buccinum angulosum* Gray, a typical adult specimen from 522 feet.

FIGS. 6, 7.—“*Oenopota*” *pyramidalis* var. *vahli* Möller from 217 feet.

FIGS. 8, 9.—*Cingula castanea* Möller var. *alaskana* Dall: 8, a juvenile from 341 feet, with egg capsules on shell; 9, an adult from 477 feet.

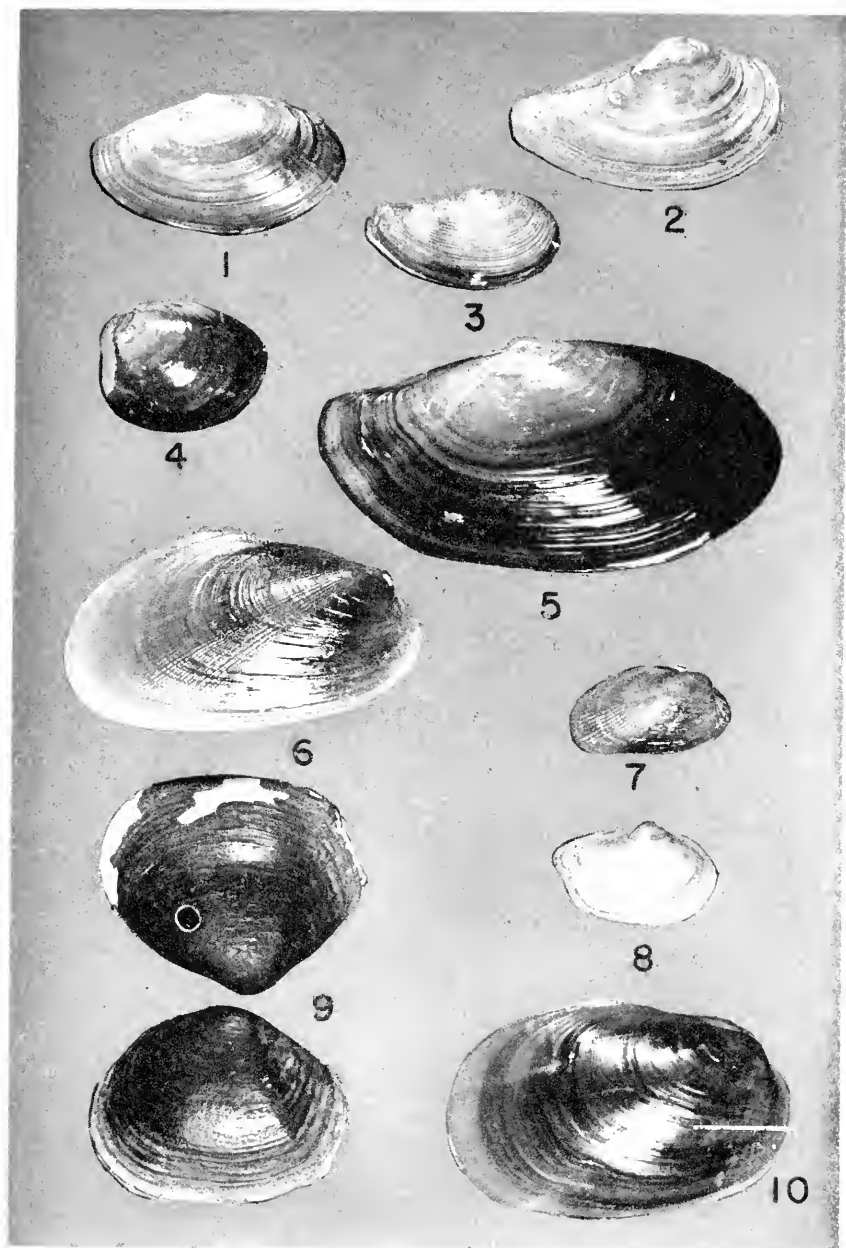
MAGNIFICATION: 1-5, \times 1.1; 6, 7, \times 5.4; 8, \times 23.7; 9, \times 11.9.



Cryptochitonidae, Lepidochitonidae, Buccinidae, Turridae, and Rissoidae. Explanation on facing page.

EXPLANATION OF PLATE 18

- FIG. 1. *Yoldia myalis* (Couthouy) from 118 feet.
FIG. 2. *Nuculana radiata* (Krause) from 80 feet (Aug. 21, 1948).
FIG. 3. *Nuculana minuta* (Fabricius) from 522 feet.
FIG. 4. *Nucula tenuis* Montagu from 118 feet.
FIG. 5. *Yoldia hyperborea* Torrell ex Lovén from 132 feet.
FIG. 6. *Musculus niger* (Gray) from 204 feet.
FIG. 7. *Musculus corrugatus* (Stimpson) from 175 feet.
FIG. 8. *Yoldia arctica* (Gray) from 28 feet (Aug. 4, 1948).
FIG. 9. *Thracia (Lamproia) adamsi*, new subgenus, new species, from 110 feet (Sept. 15, 1948).
FIG. 10. *Musculus discors* var. *laevigatus* Gray from 40 feet (Eluitkak Pass, Aug. 1, 1950).
MAGNIFICATION: All $\times 1.56$.



Nuculanidae, Nuculidae, Mytilidae, and Tridacidae. Explanation on facing page

EXPLANATION OF PLATE 19

FIG. 1.—*Panomya arctica* (Lamarck) from Unimak Pass in the Aleutians, exterior of right valve.

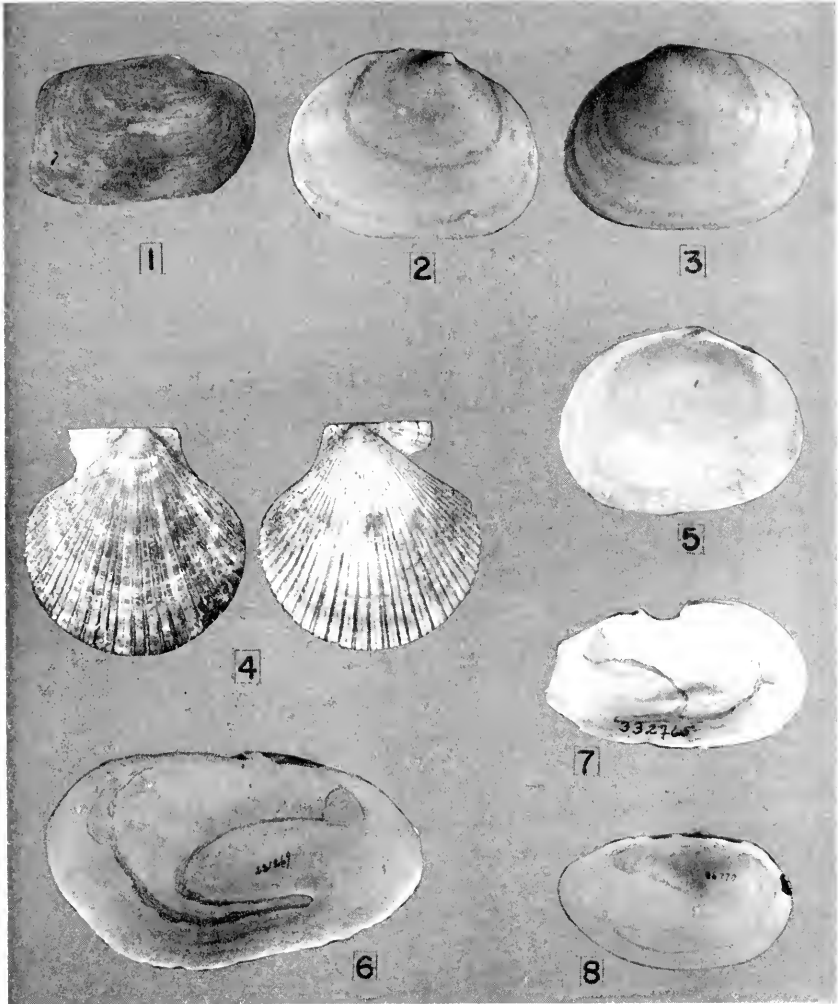
FIGS. 2, 3, 5.—*Pseudopythina compressa* Dall washed ashore Aug. 27, 1949; 2, exterior of right valve, showing spinules on dorsal margin; 3, exterior of left valve; 5, interior of left valve.

FIG. 4.—*Chlamys islandica* (Müller) from 420 feet; left, exterior of left valve; right, exterior of right valve.

FIGS. 6, 8.—*Mya japonica* Jay: 6, Dall's lectotype of *Mya intermedia*, from Chignik Bay (east side of the Alaska Peninsula), showing extreme development of anterior end and pallial sinus; 8, from Tokyo Bay, Japan (from the Stanford Collection), showing pallial sinus no deeper than that of *M. arenaria*.

FIG. 7.—*Mya pseudoarenaria* Schlessch from the Arctic (Sta. 24, Canadian Arctic Expedition), a specimen formerly assigned to *M. intermedia*.

MAGNIFICATION: 1, $\times .33$; 2, 3, 5, $\times 2.8$; 4, 6, $\times .46$; 7, $\times 1.4$; 8, $\times .35$.



Hiattellidae, Leptonidae, and Myacidae. Explanation on facing page.

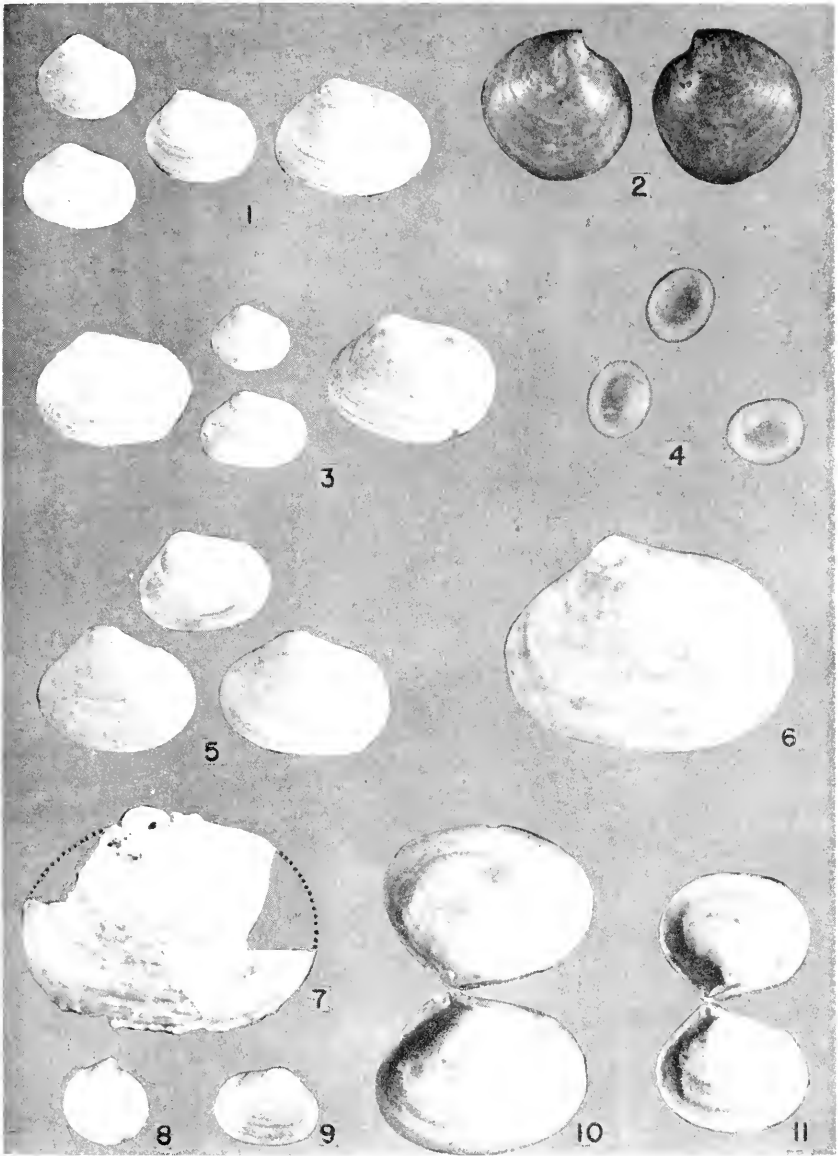
EXPLANATION OF PLATE 20

FIGS. 1, 3-7, 9-11. *Montacuta planata* (Dall): 1, a group of 4 specimens from Greenland; 3, a group of 4 specimens (USNM 159303) of Dall's cotypes of *Mysella planata* from Plover Bay; 4, embryos from a specimen (4.5 x 3.4 x 2.0 mm.) from 328 feet, Point Barrow, Alaska; 5, a group of 3 specimens (USNM 333648) of Dall's *Mysella molleri* (Mörch) from Greenland; 6, Dall's figured type of *Mysella planata* (USNM 159310) from the Shumagins; 7, portion of right valve of a specimen from 477 feet, Point Barrow, Alaska, with thinner shell, and smaller hinge structures than No. 6, being possibly a variant of *Montacuta planata*; 9, right valve of *M. planata* from 477 feet; 10, 11, views of interiors of specimens from Greenland (10, showing the resilium in place; 11, showing the hinge without the resilium).

FIG. 2. *Avinopsida orbiculata* (G. Sars) from 120 feet (Aug. 8, 1949).

FIG. 8.- *Diplodonta aleutica* Dall, juvenile from 741 feet.

MAGNIFICATION: 1, 3, 5, 10 \times 4.6; 2, \times 6; 4, \times 17.7; 6, 9, \times 4.5; 7, \times 6.1; 8, 11, \times 44.



Leptonidae, Thyasiridae, and Ungulinidae. Explanation on facing page.

EXPLANATION OF PLATE 21

FIGS. 1-3.—*Macoma moesta* (Deshayes): 1, right valve, Dall's figured type of *Macoma krausei*, from off Icy Cape, Alaska; 2, 3, specimens from Dall's type lot of *Macoma krausei*.

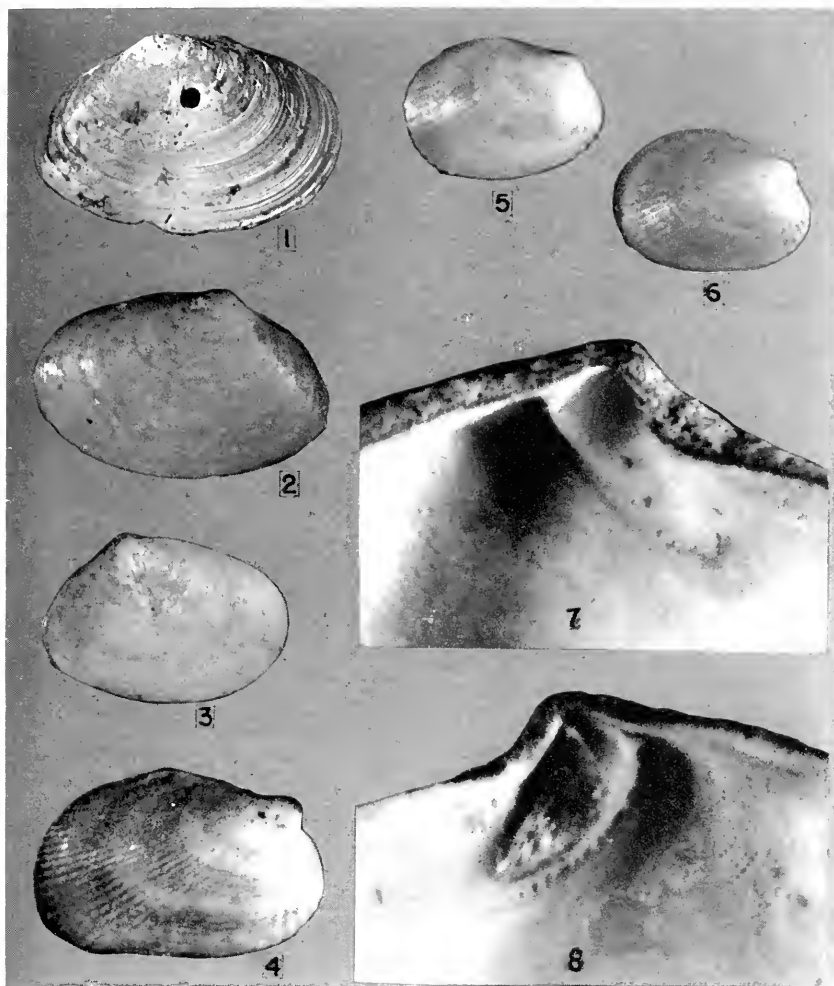
FIG. 4.—*Musculus corrugatus* (Stimpson), a juvenile from 204 feet.

FIG. 5.—*Musculus discors* (Linnaeus) var. *laccigatus* Gray, a juvenile from 477 feet.

FIG. 6.—*Musculus niger* (Gray), a juvenile from 477 feet.

FIGS. 7, 8.—*Thracia adamsi*, new species, from 110 feet (Sept. 15, 1948), interior views of hinge area: 7, right valve, showing long, buttressed resilifer; 8, left valve, showing resilifer with portion of resilium in place.

MAGNIFICATION: 1, \times 1.77; 2, 3, \times 3.15; 4, \times 15.6; 5, 6, \times 8.2; 7, 8, \times 7.9.



Tellinidae, Mytilidae, and Thraciidae. Explanation on facing page.

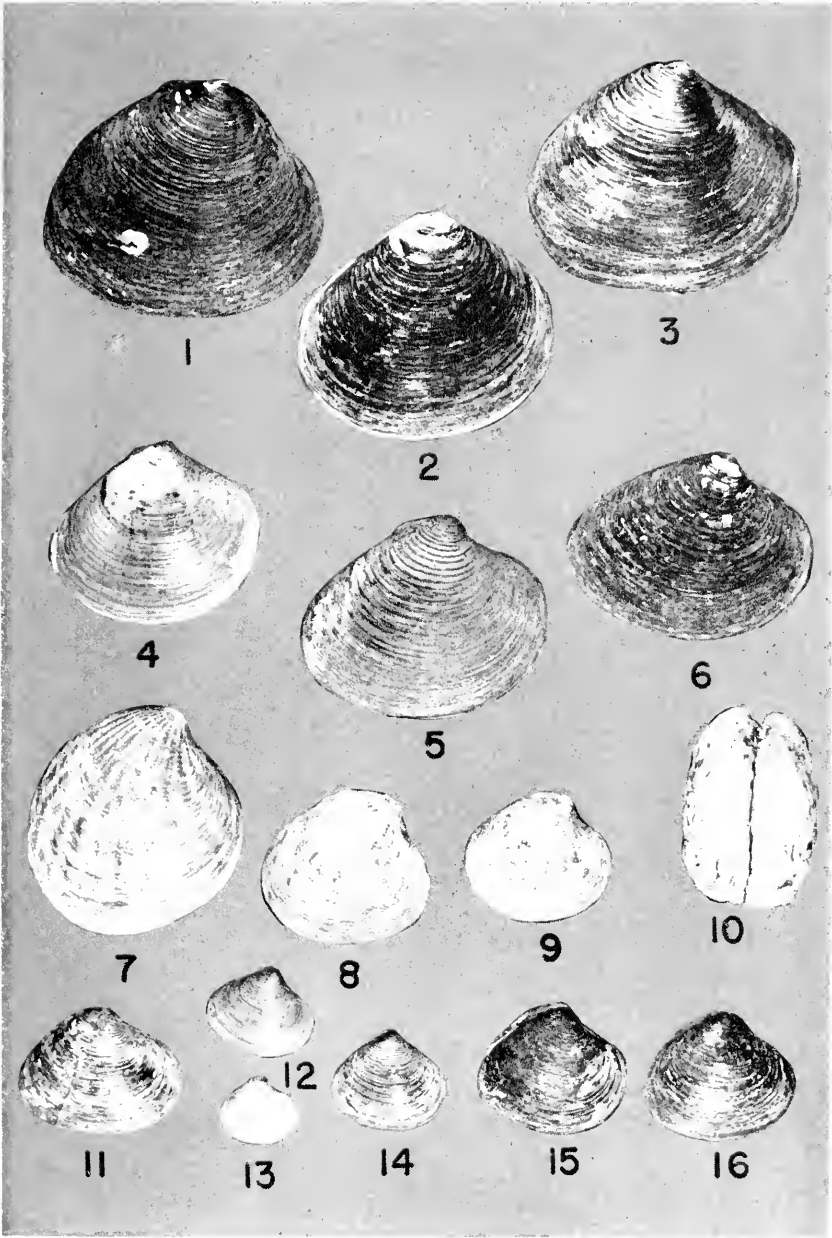
EXPLANATION OF PLATE 22

FIGS. 1-6.—*Astarte borealis* Schumacher, showing variations in shapes of anterior and posterior ends, in the ventral line, in sculpture, and in the proportion of height to length: 1, 2, from 40 feet (Eluitkak Pass, Aug. 10, 1948); 3-5, from 120 feet (Aug. 8, 1949); 6, from 40 feet (Eluitkak Pass, Aug. 1, 1950).

FIGS. 7-10.—*Cardita crassidens* (Broderip and Sowerby): 7, a high form from 110 feet (Sept. 8, 1948); 8, an intermediate form from 150 feet (Aug. 9, 1949); 9, an elongate form (= forma *paucicostata*), from same haul; 10, a specimen that grew in cramped quarters, producing a boxlike shape, from same haul.

FIGS. 11-16.—*Astarte montagui* (Dillwyn) vars.: 11, var. *warhami* Hancock, a typical var. *warhami*, from 204 feet; 12, a younger, lighter colored var. *warhami* from 125 feet; 13, a young, light colored specimen from 40 feet (Eluitkak Pass); 14-16, var. *striata* Leach from 118 feet.

MAGNIFICATION: All $\times .85$.



Astartidae and Carditidae. Explanation on facing page.

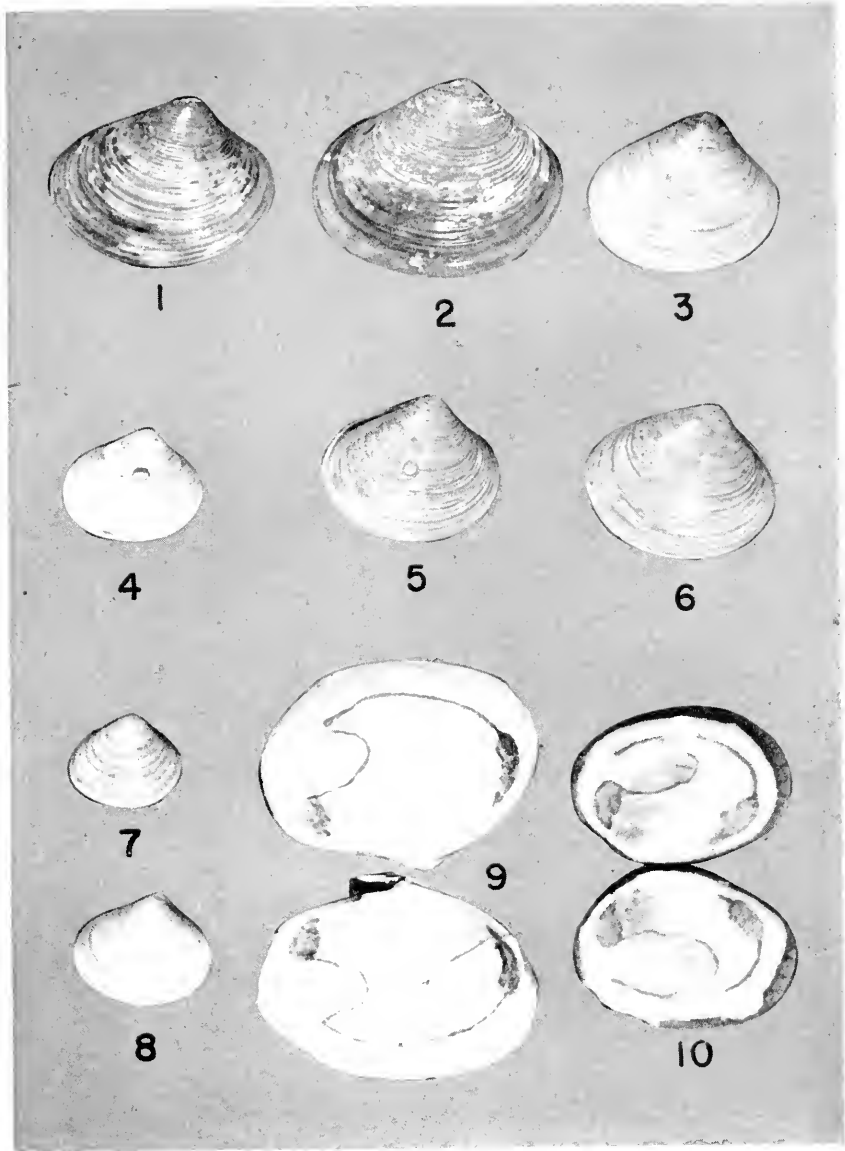
EXPLANATION OF PLATE 23

FIGS. 1-8.—*Liocyma fluctuosa* (Gould): 1, from 80 feet (Aug. 21, 1948), a fairly typical *L. fluctuosa* close to *L. "viridis"* in shape, from 80 feet (Aug. 21, 1948); 2, a specimen intermediate in shape between 1 and 3, from 246 feet; 3, a specimen that approaches the shape of *L. "beckii"* but lacks sufficient height, from 246 feet; 4-6, from 453, 80, and 341 feet, respectively, showing further variations in shape; 7, from 453 feet, showing concentric waves more widely spaced than in the preceding specimens; 8, from 341 feet, showing concentric waves very widely spaced.

FIG. 9.—*Thracia myopsis* (Möller): From 341 feet, interior view, showing difference in shape of sinus in right and left valves.

FIG. 10.—*Macoma moesta* (Deshayes): Interior view of specimen from 147 feet, showing difference in size of sinus in right and left valves, and the extent to which the periostracum covers the interior, especially on the anterior end.

MAGNIFICATION: All \times 1.2.



Tapetidae, Thraciidae, and Tellinidae. Explanation on facing page.

EXPLANATION OF PLATE 24

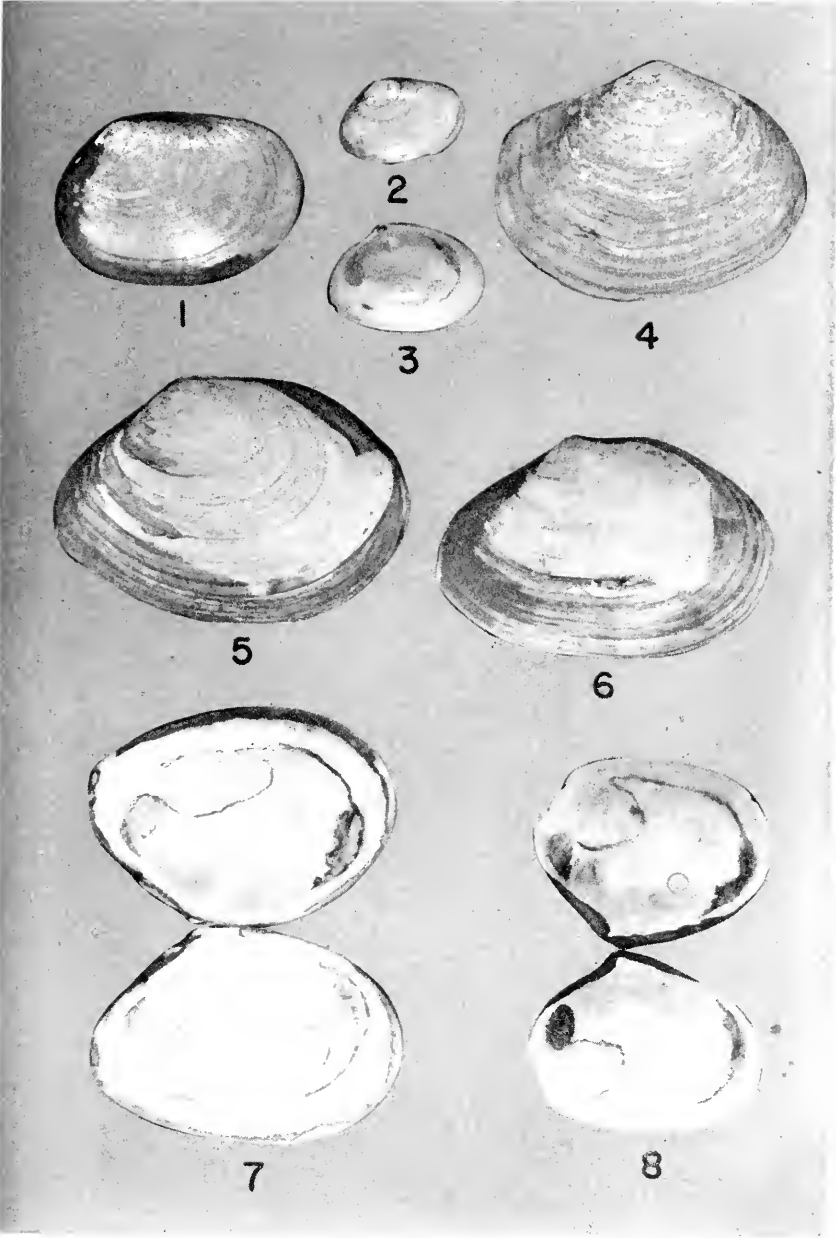
FIGS. 1-3.—*Macoma moesta* (Deshayes): 1, a typical adult from 147 feet, showing the very short posterior end and the brownish concretion along the margin except at the anterior end; 2, young specimen from 522 feet, showing exterior of right valve; 3, young specimen from 80 feet (Aug. 21, 1948), showing interior of left valve.

FIG. 4.—*Thracia myopsis* (Möller), from 341 feet.

FIGS. 5-7.—*Macoma calcaria* (Gmelin): 5, 6, from 72 feet, showing variation in shape and in height; length ratio; 7, from 80 feet (Aug. 21, 1948), showing variation in sinus of right and left valves.

FIG. 8.—*Thracia (Lamproia) adamsi*, new subgenus, new species, from 110 feet (Sept. 15, 1948), view of interior, showing variation in sinus of right and left valves.

MAGNIFICATION: All \times 1.36.

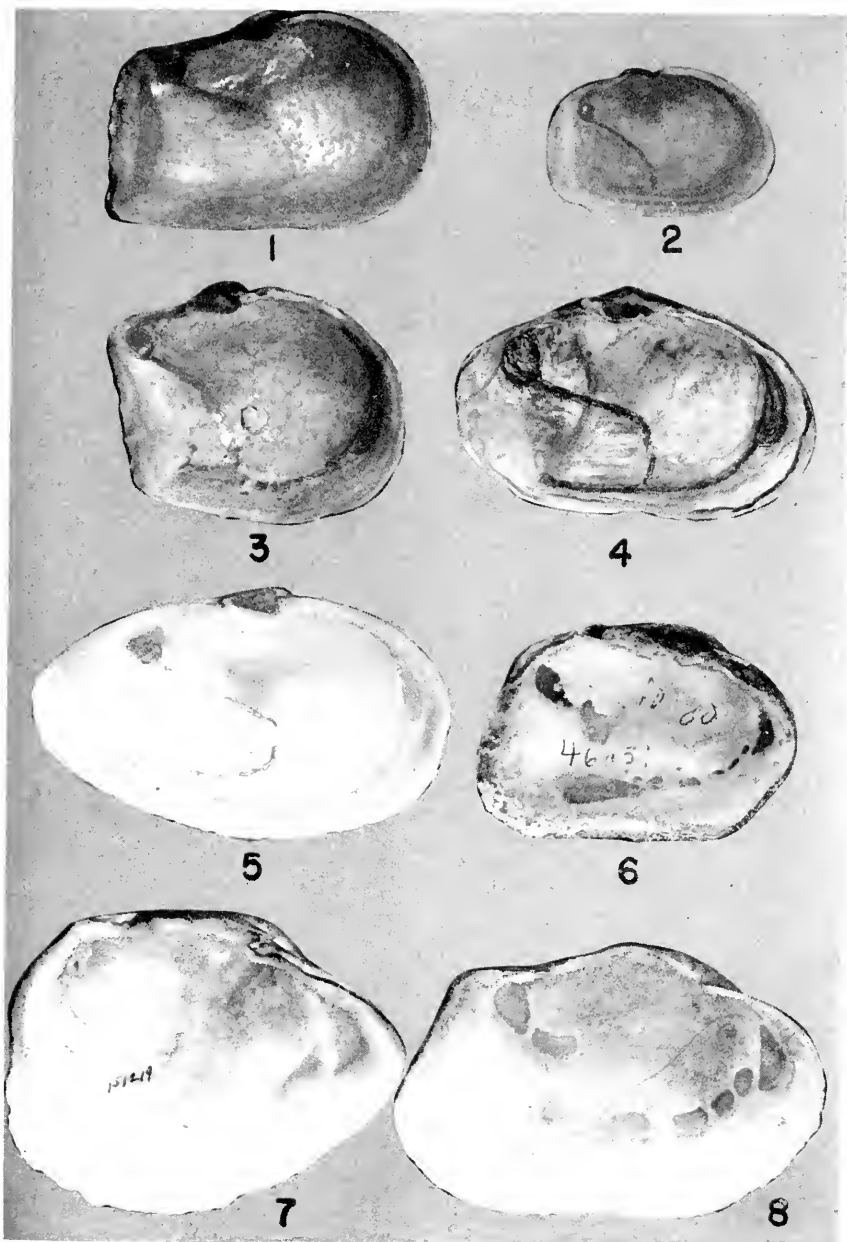


Tellinidae and Thraciidae. Explanation on facing page.

EXPLANATION OF PLATE 25

- FIGS. 1, 2.—*Mya truncata* Linnaeus: 1, a typical *M. truncata* from Puget Sound, Wash.; 2, from Point Barrow, Alaska, with a shorter posterior end and differently shaped sinus.
- FIG. 3.—*Mya truncata* var. *uddevallensis* Forbes from Point Barrow, Alaska, showing the very short posterior end and the resulting shallow sinus, also the oblique truncation that makes the ventral posterior end shorter than the dorsal.
- FIG. 4.—*Mya pseudoarenaria* Schlessch from Point Barrow, Alaska (Eluitkak Pass, 40 feet), showing the rounded posterior end, with a sinus similar to that of a typical *M. truncata*.
- FIG. 5.—*Mya arenaria* Linnaeus from Monterey Bay (Moss Landing), Calif., showing the deep sinus, the ventral line of which is not confluent with the pallial line.
- FIGS. 6, 8.—*Panomya arctica* (Lamarck): 6, from off Cape Cod, Mass.; 8, from Point Barrow, Alaska, shell broken at the hinge.
- FIG. 7.—*Panomya ampla* Dall from Captain's Bay, Amaknak Island, Alaska, showing the pointed anterior and flaring posterior end. This specimen is squarely truncate but the majority are obliquely truncate in a direction opposite to that of *P. arctica* (see figs. 6, 8).

MAGNIFICATION: ALL $\times 74$.



Myacidae and Hiatellidae. Explanation on facing page.

EXPLANATION OF PLATE 26

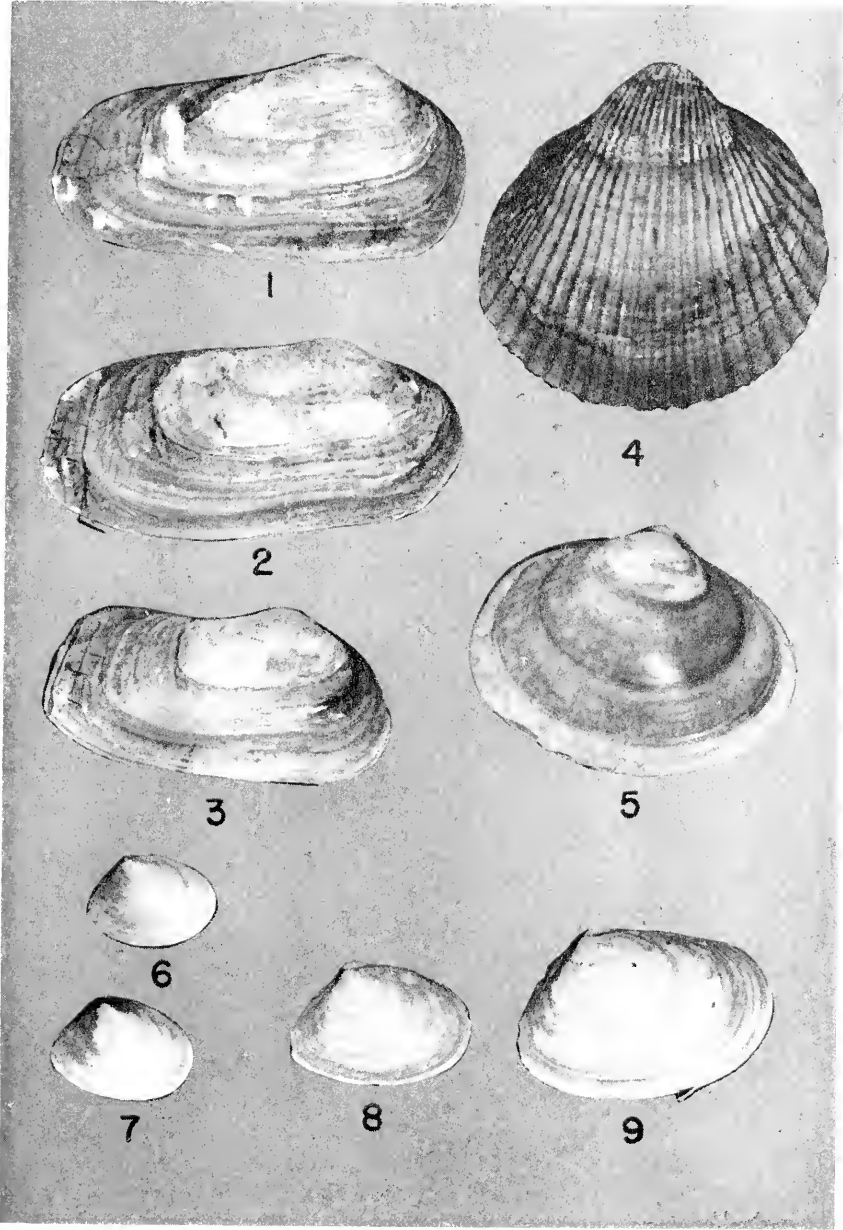
FIGS. 1-3. *Hiatella arctica* (Linnaeus) from 10 feet (Sept. 8, 1949), showing variations in anterior and posterior ends. (The elongate form most common at Point Barrow.)

FIG. 4.—*Glinocardium ciliatum* (Fabricius) from 110 feet (Sept. 8, 1948).

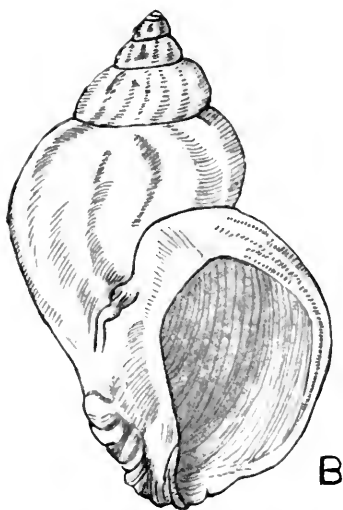
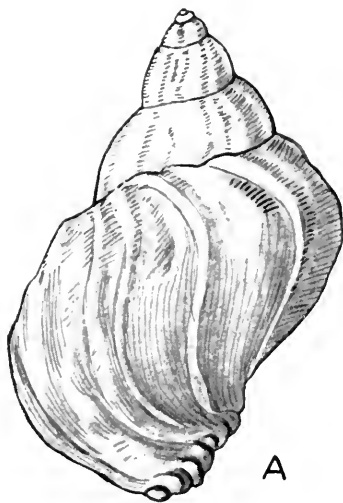
FIG. 5. —*Serripes grönlandica* (Bruguère) from 40 feet (Eluítkak Pass).

FIGS. 6-9.—*Macoma calcaria* (Gmelin): 6-8, from 132 feet; 9, from 118 feet, showing variation in shape of anterior end and in proportion of height to length.

MAGNIFICATION: All $\times 1.9$.



Hiattellidae, Cardiidae, and Tellinidae. Explanation on facing page.



A retouched Contoura print of Hermann's *Buccinum solutum* (from Hermann, 1781. pl. 2, figs. 3, 4). Hermann gave no measurements, merely stating that the shell was about the size of an egg. This shell undoubtedly is a malformed lamellose *B. undatum* Linnaeus.

PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



SMITHSONIAN INSTITUTION
U. S. NATIONAL MUSEUM

Vol. 109

Washington : 1958

No. 3413

NOTES ON ARADIDAE IN THE U. S. NATIONAL MUSEUM
(HEMIPTERA)

I. SUBFAMILY CALISIINAE

By NICHOLAS A. KORMILEV ¹

Through the good offices of Dr. Reece I. Sailer and Dr. Carl J. Drake, I had the privilege to study the unidentified Aradidae in the collections of the U. S. National Museum in Washington, D. C., including the Drake Collection. I wish to express my thanks to them.

This paper, the first in a series, deals with the subfamily Calisiinae, which is surely one of the oldest, if not the oldest, among Aradidae.²

All species of Calisiinae, with the exception of *Aradacanthia multicalcarata* Costa, are very small—less than 4 mm. long—and difficult to collect. Consequently, our knowledge of their distribution and habits is far from complete; but fragmentary as this knowledge is, it indicates that Calisiinae are almost tropicopolitan, penetrating sometimes into temperate zones; i. e., *Calisius salicis* Horváth, 1913, was found in northern Yugoslavia and *Calisius annulicornis* Bergroth, 1913, in Tasmania. No species are known from tropical Asia, but *Calisius salicis* Horváth is recorded from Syria, and

¹ Formerly with Instituto de Ciencias Naturales, San Miguel, Buenos Aires, Argentina.

² In the division of Aradidae (or Aradoidea, as used by some modern European authors) I am following the American authors, considering them as one family, with five subfamilies: Calisiinae, Aradinae, Mezirinae, Isoderminae, and Aneurinae.

Aradacanthia multicalcarata Costa, 1864, from Indonesia. Matsuda and Usinger (1957) reported nine species of *Calisius* from Micronesia.

The most important characters separating Calisiinae from other subfamilies are the presence of tergum VIII in the males as well as the females; the scutellum covering most of the hemelytra, with correlated reduction of the corium and its venation; and the presence of a double row of tubercles or teeth on the outer margin of the abdomen.

Calisiinae includes only three genera: *Calisius* Stål, 1860, *Aradacanthia* Costa, 1864, and *Calisiopsis* Champion, 1898. The first genus had 33 species scattered all over the world, one of them fossil. The latter two were monotypic, *Aradacanthia* known from the Orient, and *Calisiopsis* from Central America.

In this paper are described six new species of the genus *Calisius* (four American and two Australian) and two new species of the genus *Calisiopsis* (one from southeastern Brazil and one from Mexico).

Key to the genera of the subfamily Calisiinae

1. Body very broad, abdomen almost discoidal; pronotum with each lateral border deeply emarginate in the middle, forming four (2+2) rounded and densely denticulated lobes; stridulatory mechanism present.

Aradacanthia Costa

Body elongately ovate or ovate, abdomen never discoidal; lateral borders of the pronotum at most slightly emarginate, or almost straight, without lobes; stridulatory mechanism absent. 2

2. Anterior process of the head more robust; antenna normal, generally with the segments increasing in length from the first to fourth; hypopygium of the males big, dorsocaudal or caudal in position, clearly visible from above.

Calisius Stål

Anterior process of the head relatively narrower and more protruding; the first three antennal segments very short, moniliform, the fourth as long, or almost as long, as the first three together, and granulated; hypopygium of the male flat, displaced on the ventral surface, and removed from the hind border, not visible from above. *Calisiopsis* Champion

As already mentioned, Calisiinae differs from other subfamilies by tergum VIII being present not only in the females, but also in the males.

In *Calisius* Stål, tergum VIII of the male is a transverse, short sclerite, placed behind and a little lower than tergum VII and before the hypopygium (fig. 1).

In *Calisiopsis* Champion, tergum VIII is produced posteriorly in a curious process having the form of an inverted gutter; its borders are almost closed posteriorly, thus forming a tube (fig. 2). This process serves as a sheath for the pointed tip of the male organ. The lateral parts of tergum VIII are bent on the ventral side of the abdomen posteriorly along the split of the process, resulting in the

displacement of the hypopygium toward the ventral surface well removed from the hind margin of the abdomen; sternum VIII is moved further forward, its lobes (genital lobes) are placed on each side of the flattened hypopygium as slender, long spurs projecting far beyond the hind border of the latter, but still not visible from above.

In *Aradacanthia* Costa, tergum VIII has the form of a small, subtriangular, apically rounded lobe, placed behind and slightly lower than tergum VII, and serves as a cover for the excavated upper surface of the hypopygium (fig. 3). The hypopygium is caudal in position, rather small in comparison with that of the genus *Calisius*, and subpyriform in shape. Sternum VIII is crescent-shaped; its lobes are big, flat, apically bilobate, and the spiracle is placed between the lobes so that the tip of the genital lobes looks tricuspidate. Antenna of *Aradacanthia* with the first two segments short, and apical two longer, proportions being 8:5:12:14; the fourth segment granulated as in *Calisiopsis*.

Calisiinae are very rare, many of the species known only from a single, or very few specimens; this has no doubt contributed to the lack of a clear understanding of the relationship of Calisiinae to the other subfamilies of Aradidae.

Genus *Calisius* Stål, 1858

Calisius Stål, 1858, K. Vet. Akad. Handl., Stockholm, vol. 2, no. 7, pp. 1-84.

Aradosyrtris Costa, 1864, Ann. Mus. Zool. Univ. Napoli, vol. 2, p. 132.

Type of genus: *Calisius pallipes* Stål, 1858, by monotypy.

Calisius is represented in America by 13 species, of which four are here described. Distribution is tropical or subtropical; from Florida to northern Argentina (Tucumán).

Calisius gracilis, new species

FIGURES 4, 5

MALE: Head (fig. 4) shorter than wide through the eyes (35:38); anterior process (tylus and juga together) strong, parallel, anteriorly rounded, and without any notch, densely covered with erect, blunt tubercles; apex attaining the tip of the 3d antennal segment. Antenniferous spines short, dentiform, scarcely reaching the tip of the 1st antennal segment. Eyes semiglobose. Postocular spines each small, dentiform, slightly projecting beyond the outer margin of the eye. Infraocular carinae formed by a row of blunt, erect tubercles. Vertex with V-shaped row of blunt tubercles; the space between them covered with smaller granulation. Antenna short and slender; the 1st joint ovate, the 2d subglobular, the 3d tapering toward the base, the 4th fusiform; the proportions are (1 to 4): 6:3:8:10. Rostral groove

closed posteriorly, its borders low, granulated; rostrum reaching to the hind border of the groove.

Pronotum (fig. 4) trapezoidal, much shorter than wide across the humeri (28:68), declivous forward; interlobal, transverse depression feebly marked; fore border subtruncate; lateral margins divergent posteriorly, slightly emarginate in the middle, near the anterior angles provided with a row of 4-5 big, blunt, whitish tubercles, the middle ones largest; humeri convex, rounded, and provided with a double row of big, blunt tubercles; hind border convex in the middle and laterally. Fore disc with four (2 + 2) big, erect, blunt tubercles; hind disc with four (2 + 2) longitudinal rows of similar tubercles; these rows are continued on the base of the scutellum; the inner rows of the hind disc correspond to two rows of the fore disc, and are divergent posteriorly; the outer ones are curved, with the convex side outward. The discs between the tubercles are roughly punctured.

Scutellum big, much longer than wide (82:50), in the middle laterally, slightly emarginate; at the base with a high, triangular elevation, posteriorly continued into a median ridge; this elevation is provided with four (2 + 2) rows of big tubercles, forming a continuation of those of the pronotum; between the larger tubercles are scattered smaller granulae. The median ridge is gradually tapered to the tip and is provided with a row of thin, erect teeth; similar rows of thin, erect teeth are on the lateral margins, forming a palisade on either side; the disc between the margins and median carina is roughly punctured, but without granulation.

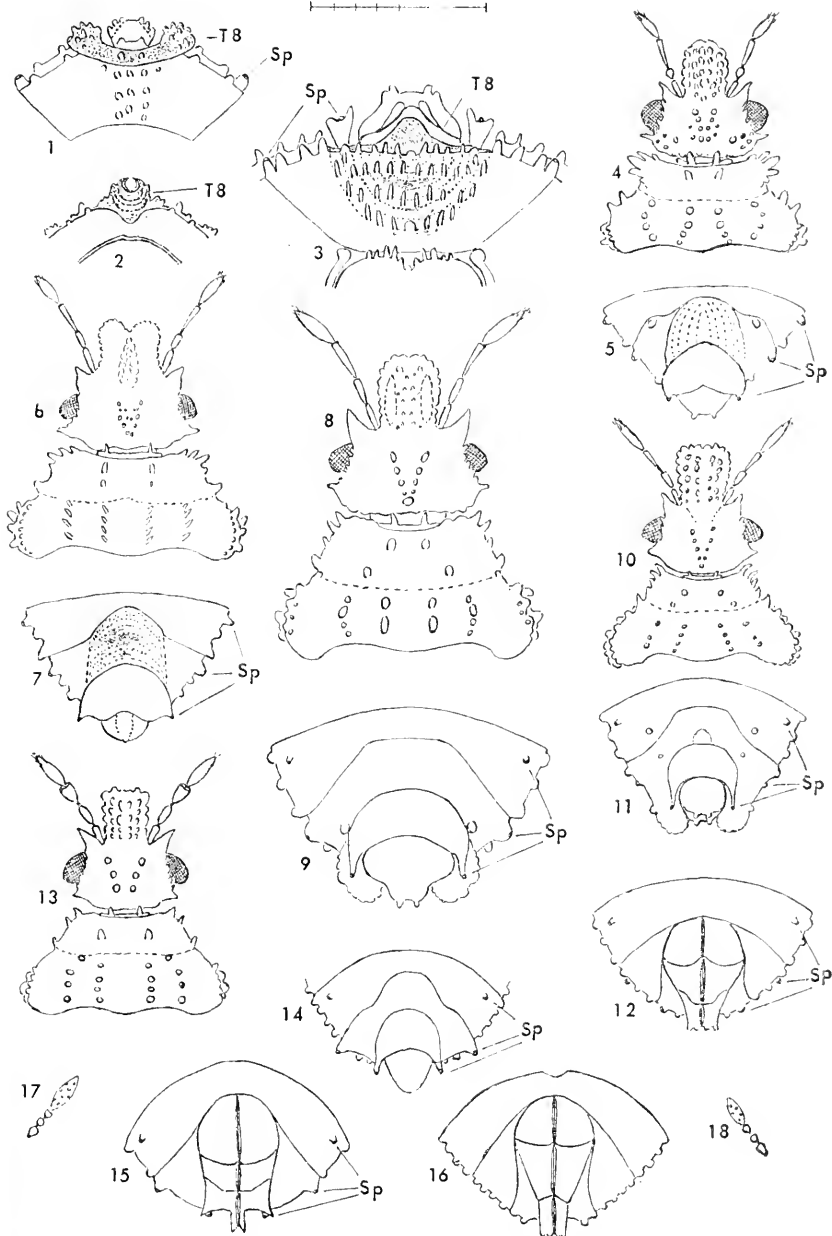
Hemelytra mostly concealed beneath the scutellum, each with only the narrow, outer edge of the greatly reduced corium exposed.

Abdomen ovate, slightly longer than wide (80:78), as measured from below. Connexivum very wide; each segment with a round, callous

FURTHER EXPLANATION OF FIGURES 1-18

- 1-3, Tip of abdomen, dorsal aspect, male: 1, *Calisius insignis*, new species; 2, *Calisiopsis amplexiceps* Champion; 3, *Aradacanthia multicalcarata* Costa.
4, 5, *Calisius gracilis*, new species, male: 4, head and pronotum; 5, tip of abdomen, ventral aspect.
6, 7, *C. bilobatus*, new species, male: 6, head and pronotum; 7, tip of abdomen, ventral aspect.
8, 9, *C. insignis*, new species, male: 8, head and pronotum; 9, tip of abdomen, ventral aspect.
10-12, *C. longiventris*, new species: 10, male, head and pronotum; 11, male, tip of abdomen, ventral aspect; 12, female, tip of abdomen, ventral aspect.
13, 14, *C. hackeri*, new species, male: 13, head and pronotum; 14, tip of abdomen, ventral aspect.
15, *C. australis*, new species, female, tip of abdomen, ventral aspect.
16, *Calisiopsis minutus*, new species, female, tip of abdomen, ventral aspect.
17, 18, Antenna of female: 17, *Calisiopsis amplexiceps* Champion; 18, *C. minutus*, new species.

0 .25 .5 1mm



FIGURES 1-18.—Head, pronotum, tip of abdomen, and antenna of various species of *Calisius*, *Aradacanthia*, and *Calisiopsis*. Key to symbols: T8, tergum VIII; Sp, spiracle. Further explanation on facing page.

spot, surrounded by scattered granulations; the disc of tergum VII elevated, and transversally depressed in the middle, almost saddle-shaped; the exterior borders of the abdomen with two (dorsolateral and ventrolateral) rows of big, blunt, semierect tubercles. Venter rather smooth, with fine and dense punctation, but without granulation. Sternum VII longitudinally inflated (fig. 5). Spiracles II-V ventral, progressively nearer the margin, those of VI lateral, of VII almost dorsal, both placed at the apex of a tubercle. Hypopygium caudal in position, not very big, provided with a median sulcus, and with two (1 + 1) rows of granulae at the upper end of the sulcus.

Legs finely granulated, unarmed.

Color: Orange-yellow; scutellum testaceous, with two subbasal, lateral spots, and subapical, transverse band, whitish. Connexivum yellow, its outer border bicolored with alternating testaceous and whitish on each segment. Granulation, with rare exceptions, more pale than the background.

Size: Total length 2.83 mm.; width of pronotum 1.10 mm.; width of abdomen 1.27 mm.

HOLOTYPE: Male (USNM 64204); Livingston, Guatemala, Nov. 5, Barber and Schwarz.

REMARKS: *Calisius gracilis*, new species, is somewhat allied to *confusus* Kormilev, 1953, but is smaller; the head is wider than long; antennae shorter and with different proportions; and granulation of the pronotum and scutellum more pronounced. It is allied also to *affinis* Barber, 1954, but has different proportions of the antennal segments, a granulated median carina of the scutellum, and different coloration.

Calisius bilobatus, new species

FIGURES 6, 7

MALE: Head (fig. 6) slightly shorter than wide through the eyes (40:42); anterior process reaching the tip of the 3d antennal segment, slightly widening forward, with the tip distinctly notched and rounded laterally, so that it looks bilobate; the antenniferous spines are dentiform, but wider at the base, not so slender as in the preceding species; the postocular spines rather robust and distinctly protruding beyond the outer margin of the eyes; the proportions of the antennal segments (1-4) are 7:5:10:13.

Pronotum much shorter than wide across the humeri (30:75); the spiculoid, erect tubercles of the pronotum are fine and high.

Scutellum much longer than wide (95:55); the fine, erect teeth of the median carina and the borders are particularly long and dense.

Abdomen longer than wide (95:85), as measured from below, more tapered posteriorly than in *gracilis*; the outer rows of tubercles on

the connexivum are stouter and shorter than in other species. Spiracles of segments II–V ventral, those of VI and VII lateral and visible from above. Sternum VII longitudinally inflated (fig. 7). Hypopygium rather large, caudal in position.

Color: Ochre-yellow, mottled with brown and whitish; scutellum with brown spots around the subbasal lateral whitish spots, at the middle of the lateral margins and on the tip; connexivum bicolorous with brown and white lateral granulation.

Size: Total length 3.33 mm.; width of pronotum 1.23 mm.; width of abdomen 1.40 mm.

HOLOTYPE: Male (USNM 64205), Bolivia, W. M. Mann, Biological Expedition, 1921–1922.

REMARKS: *Calisius bilobatus*, new species, is also somewhat allied to *confusus* Kormilev, 1953, but differs from it by the bilobate anterior process of the head, different proportions of the antennal segments, and finer and longer granulation of the pronotum and scutellum.

Calisius insignis, new species

FIGURES 8, 9

MALE: Head (fig. 8) as long as wide through the eyes (24:24), anterior process big, parallel, anteriorly rounded, laterally impressed, roughly granulated, attaining the middle of the 3d antennal segment; antenniferous spines stout, dentiform, divaricating and directed slightly downward, almost reaching tip of the first antennal segment; eyes subconical; postocular spines small, tuberculiform, each attaining the outer margin of the eye. The infraocular carinae formed by a few, blunt granules. Vertex with V-shaped, rough granulation; between the latter and infraocular carinae, depressed and with a finer, scale-shaped granulation. Antenna slender, segments with proportions (1 to 4) of 4:5:6:8; the 1st segment subcylindrical, the 2d and 3d tapering toward the base, the 3d slightly narrower than the 2d, the 4th fusiform. Rostrum not attaining the hind border of the groove.

Pronotum less than half as long as wide across the humeri (20:43); anterior border truncate; lateral borders convergent, in the middle slightly emarginate; anteriorly with a single but at the humeri with a triple row of big, blunt teeth. Fore disc with two (1+1) posteriorly divergent rows of big, erect teeth (each row contains three widely separated teeth). Hind disc with four (2+2) short, parallel rows of similar teeth (the inner rows with two, the outer with four, closely placed teeth); fine, scale-shaped granulation dispersed between the teeth.

Scutellum much longer than wide (62:35), slightly constricted near middle. The basal triangular elevation short, with six (3+3) big,

blunt tubercles placed in two rows: four in the basal row and two in the apical row; dispersed, fine, scale-shaped granulation between these tubercles. Median carina stout, granulated; the lateral borders also granulated, granulae are the highest in the middle and gradually lower toward the base and the tip. Disc of the scutellum roughly punctured.

Abdomen (fig. 9) elongately ovate, longer than wide (80:52); lateral margin parallel, anteriorly and posteriorly roundly converging. The discs of the connexiva with scale-shaped, fine granulation. The disc of tergum VII longitudinally elevated, and with bigger granulation. Sternum VII laterally produced backward as two (1+1) big, rounded, granulated lobes, similar to *affinis* Barber, 1954. The genital lobes small, cylindrical, placed beneath the big lobes, and not visible from above. Spiracles II-VI ventral, placed progressively closer to the border, those of VII lateral, situated on tubercles, those of the lobes (VIII) terminal. Venter covered with fine scale-shaped granulation; propleura with a group of larger granulations.

Color: Pale testaceous; the fore half of the head, antennae, the apical third of the scutellum, and the scale-shaped granulation of the connexivum more pale, sometimes whitish.

Size: Total length 4.27 mm.; width of pronotum 1.42 mm.; width of abdomen 1.73 mm.

HOLOTYPE: Male (USNM 64206), Livingston, Guatemala, July 5, H. S. Barber.

REMARKS: *Calisius insignis*, new species, is allied to *contubernalis* Bergroth, 1913, from which it differs in having antennae slightly shorter than the head (23:24). Second segment slightly shorter than the first (5:4) and failing to reach the tip of the anterior process; hypopygium on the underside without longitudinal depressions, but with two (1+1) medially convergent rows of granulae. Also it is allied to *affinis* Barber, 1954, in having similar big, rounded, posteriorly protruding lobes on sternum VII, but *insignis* is larger, has the margins of the scutellum denticulate, and differently proportioned antennal segments.

Calisius longiventris, new species

FIGURES 10-12

MALE: Head (fig. 10) almost as long as wide through the eyes (41:40). Anterior process parallel, anteriorly rounded, reaching to the tip of the 3d antennal segment. Antenniferous tubercles dentiform, exteriorly parallel, each reaching to the tip of the first antennal segment. Eyes small. Postocular tubercles small, dentiform, each attaining the outer margin of the eye. Infraocular carinae formed by a few tubercles; shelves (space between the middle of the vertex

and infraocular carinae) slightly longitudinally depressed. Vertex with V-shaped row of tubercles. Antennae slender; with proportions of the antennal segments (1 to 4) 6:6:7:13. Rostrum reaching the hind border of the rostral groove.

Pronotum much shorter than wide (27:67). Fore disc with four (2+2) tubercles forming two, slightly divergent backward rows, which are continued on the hind lobe (outer rows). Hind lobe with four rows of tubercles; the outer rows consist of three tubercles each, the inner ones of four smaller tubercles; all four rows are strongly divergent posteriorly.

Scutellum very long (103:57); the basal triangular elevation provided with six (3+3) bigger and a few smaller tubercles; median carina finely granulated; margins of the scutellum each with a row of small, erect teeth, running to two-thirds of their length, then without teeth. Disc roughly punctured, and with a few dispersed, erect tubercles.

Abdomen (figs. 11, 12) very long (100:81); each connexivum with two brown tubercles and 1 yellow tubercle (upper row). Tergum vii longitudinally inflated in the middle; sternum vii with two (1+1) big, rounded lobes, protruding far beyond the tip of the hypopygium; genital lobes (of sternum viii) shorter than the hypopygium and not visible from above. Hypopygium small, posteriorly granulated. Spiracles of segments ii-vi ventral, those of vii lateral and visible from above. Venter finely granulated.

Color: Ochre-yellow, mottled with brown; scutellum whitish; basal triangle, the tip (narrowly), and some irregular spots on the disc brown; lateral borders in the middle piceous; ventral surface of the body with carmine punctures and spots.

FEMALE: Sexual dimorphism is rather pronounced, the female having a much shorter and more ovate abdomen, without big rounded lobes on sternum vii, and with only segment ix protruding posteriorly. Proportions: head 38:40; pronotum 32:70; scutellum 100:55; abdomen 100:86; antennal segments (1 to 4) 6:7½:7½:13.

SIZE: Total length of male and of female, 3.47 mm. Width of pronotum: male, 1.12 mm.; female, 1.17 mm. Width of abdomen: male, 1.35 mm.; female, 1.43 mm.

HOLOTYPE: Male (USNM 64207), Paraiso, Canal Zone, Panama, Jan. 23, 1911, E. A. Schwarz.

ALLOTYPE: Female, same data as holotype.

PARATYPES: 14 paratypes, same data as holotype, deposited in the U. S. National Museum and in the collection of the author.

REMARKS: *Calisius longiventris*, new species, is allied to *affinis* Barber, 1954, but is lighter in color; the body of the male, particularly the abdomen, is much longer and posteriorly more narrowed; and the

rounded lobes of sternum VII are bigger and more protruding posteriorly. From *insignis*, new species, to which it is also allied, *longiventris* differs in its smaller size, different proportions of the antennal segments, and having the basal two-thirds of lateral margins of the scutellum denticulated.

Calisius australis, new species

FIGURE 15

FEMALE: Head as long as wide through the eyes (18:18); anterior process almost ovate, anteriorly rounded, at the base slightly constricted, roughly granulated, reaching to the tip of the 3d antennal segment; antenniferous spines acute, strongly divaricate, scarcely reaching the tip of the first segment; eyes big, semiovale, protruding; postocular spines small, tuberculiform, not reaching the outer margins of the eyes; infraocular carinae each formed by three erect tubercles. Vertex flat, with V-shaped row of granules. Antennae slender, the first segment subcylindrical, the 2d ovate, the 3d slightly tapering toward the base, the 4th fusiform; proportions of the antennal segments (1 to 4) 3:3½:4:7½. Rostrum slightly shorter than the rostral groove.

Pronotum much shorter than wide across the humeri (19:34); anteriorly truncate; collum well marked and provided with two (1+1) big, erect tubercles; lateral margins converging anteriorly slightly constricted medially. Fore disc with two (1+1) erect tubercles, followed by four (2+2) divergent rows of similar tubercles, continued on the hind disc. Lateral margins of the fore lobe each with three big, blunt teeth. Hind lobe inflated and coarsely punctured; disc with four (2+2) rows of erect tubercles; the inner rows are subparallel, the outer ones curved; humeri each with a double row of similar tubercles.

Scutellum longer than wide at the base (47:27); the basal triangular elevation very high; middle of base provided with a transverse, curved row of four depressed tubercles, and the disc with four additional very big tubercles, of which the inner ones are semideflated, the outer ones erect. The median ridge with a row of dense, erect tubercles. The lateral margins with a row of erect teeth along the basal half; at the tip of the scutellum are placed two (1+1) small tubercles. The disc is roughly punctured.

Abdomen elongately ovate (59:40), with the connexivum obliquely raised; the lateral borders with a double row of smaller, rather obliterated tubercles, more obliterated in the dorsolateral than in the ventrolateral row. Spiracles of segments II-VI ventral, placed far from the lateral margin, those of VII dorsolateral, each placed on the apex of a tubercle; those of the genital lobes (VIII) terminal. Lobes of segment VIII granulated, divergent, reaching the middle of IX, the latter slightly

emarginate at the tip. Venter roughly punctured and with a few dispersed tubercles.

Color: Pale yellow-brown; antennae pale yellowish, segment iv pale testaceous; tubercles on the hind disc of the pronotum testaceous; scutellum testaceous, with a whitish band in the shape of two hooks forming an inverted V. Connexivum yellow; segment ii (the first visible) entirely testaceous, segments iii-v testaceous at the anterior half of the exterior border, and segments vi and vii entirely testaceous; segment viii whitish. Ventral surface orange-yellow; pleurae and the tip of the venter testaceous; the disc of the venter whitish.

HOLOTYPE: Female, Brookfield, Australia, Oct. 20, 1928, H. Hacker; deposited in Drake Collection, U. S. National Museum.

ALLOTYPE: Male, Southport, Australia, Jan. 26, 1929, H. Hacker; deposited in Drake Collection, U. S. National Museum.

REMARKS: *Calisius australis*, new species, is allied to *annulicornis* Bergroth, 1913, but is smaller, color of the body is paler, and proportions of the antennal segments are different.

Calisius hackeri, new species

FIGURES 13, 14

Calisius hackeri, new species, is so closely allied to *australis*, new species, that I first believed it to be the opposite sex of the latter. After closer examination, I found distinctive characters, which allowed the two to be distinguished as separate species.

The antenna of *hackeri* is relatively shorter, the ratio between the length of the antennae and width of the head through the eyes being 38:34, as compared to only 38:37 in *australis*.

The 4th segment of the antennae is distinctly shorter than the 2d and 3d together (12:15), whereas in *C. australis* the same ratio is 15:15.

The 2d and 3d antennal segments are ovate and wider than the first, while in *australis* they are of the same width and taper towards the base, subconically.

The postocular spines are relatively shorter, and definitely fail to reach the outer margin of the eyes; the inner rows of the tubercles on the hind lobe of the pronotum have relatively smaller tubercles, five in each row, while in *australis* they are larger and only four in each row.

Tubercles on the basal triangular elevation of the scutellum are not depressed, the two inner ones in the basal row are very low and smaller than the outer ones, while in *australis* the inner tubercles are the larger and all are depressed. The apical margin of the scutellum has six small tubercles (3+3), decreasing in size from the inner to the outer ones, whereas there are only two (1+1) very small tubercles similarly located on *australis*; both rows of the tubercles (dorsolateral and ventrolateral) on the outer borders of the abdomen are well pro-

nounced, while in *australis* they are mostly obliterated in the dorso-lateral row, being more pronounced only at the base and at the tip of the abdomen.

The color of *hackeri* is slightly darker than that of *australis*, but the pattern of the scutellum is the same.

In *hackeri* the spiracles of segments II-VI are ventral, while those of segment VII are dorsolateral.

All other characters agree with *australis*.

Proportions of *hackeri*, male, are as follows: head 38:38; antennae 7:8:7:12; pronotum 35:65; scutellum 50:85; abdomen 81:75.

SIZE: Total length 3.0 mm.; width of pronotum 1.07 mm.; width of abdomen 1.23 mm.

HOLOTYPE: Male, Southport, Queensland, Australia, H. Hacker, Jan. 26, 1929; deposited in the Drake Collection in the U. S. National Museum.

REMARKS: This species is dedicated to Mr. H. Hacker, an Australian entomologist who collected this as well as many other curious species of Australian Aradidae.

Genus *Calisiopsis* Champion, 1898

Calisiopsis Champion, 1898, in Godman and Salvin, *Biologia Centrali-Americana*, vol. 2, p. 67.

Type of genus: *Calisiopsis amplex* Champion, 1898.

This genus was monobasic, with a single species, *Calisiopsis amplex* Champion, 1898, described from Panama, though Champion indicated that one of his three specimens, without head, probably belonged to another species.

In 1951 I received one specimen of *Calisiopsis* from the Rev. Pio Buck, S. J., professor of the Colegio Anchieta, Porto Alegre, Rio Grande do Sul, Brazil, and, somewhat later, I received some additional specimens from Mr. Plaumann, Nova Teutonia, Santa Catarina, Brazil. Although it was difficult to understand how a species with such limited power of flight could be distributed in Central America and southeastern Brazil, Champion's description fits my specimens and I identified them as *Calisiopsis amplex* Champion. As the male of *Calisiopsis* was unknown, I described it (Kormilev, 1956, p. 149).

Among Aradidae from the U. S. National Museum I have now seen four specimens of *Calisiopsis* from Mexico. Two of them fit Champion's description and drawings and two do not, but they all are clearly different from the Brazilian specimens. As a result we have now three different species. Assuming that the specimens from Tomazunchale, which fit the Champion's description and drawings,

are *Calisiopsis ampliceps* Champion, 1898, the other two species are here described as new.

***Calisiopsis ampliceps* Champion, 1898**

FIGURE 17

Calisiopsis ampliceps Champion, 1898, in Godman and Salvin, *Biologia Centrali-Americana*, vol. 2, p. 67, pl. 5, figs. 4, 4a, 4b.

Heretofore known only from the female.

MALE: Head shorter than wide through the eyes (33:47); anterior process scarcely longer than wide at the base (18:17); the proportions of the antennal segments (1 to 4) are 5:3:3:13, the 4th segment being longer than the three preceding segments together. Seen from the front, only one-third of the eye is above the level of the vertex. Pronotum very short (35:78); scutellum much longer than wide at the base (101:67); abdomen longer than wide (110:92).

Size: Total length 3.23 mm.; width of pronotum 1.23 mm.; width of abdomen 1.53 mm.

SPECIMEN EXAMINED: Allotype male, Tomazunchale, Mexico, Apr. 3, 1946, on orchid plants; in the U. S. National Museum.

***Calisiopsis minutus*, new species**

FIGURE 18

FEMALE: Similar to *Calisiopsis ampliceps* Champion, 1898, but distinctly smaller and more yellowish; scutellum more whitish, the four (2 + 2) white spots fused together; the few scattered big granules on the disc of the scutellum are almost obliterated; eyes relatively smaller; the infraocular shelves less depressed; but the main difference is in the 4th antennal segment, which is slightly shorter than the three preceding antennal segments together (10:11), the proportions of the segments (1 to 4) being: 5:3:3:10. (See figs. 16, 17 and 18.) Other proportions are: head 35:43; pronotum 30:61; scutellum 80:57; abdomen 83:80.

Color: Yellow, with a fine whitish incrustation; eyes brown; some of the tubercles on the pronotum and five small tubercles in the middle of the lateral borders of the scutellum piceous; the basal triangle and tip of the scutellum, and two or three tubercles of each connexivum, pale brown.

Size: Total length 2.93 mm.; width of pronotum 1.02 mm.; width of abdomen 1.33 mm.

HOLOTYPE: Female (USNM 64208), Tampico, Mexico, December 28, E. A. Schwarz.

PARATYPE: Female, same data as holotype, in collection of the author.

Calisiopsis brasiliensis, new species

Calisiopsis amplexes Kormilev (not Champion), Anal. Soc. Cient. Argentina, vol. 162, nos. 5, 6, p. 149, figs. 1-3.

Since the detailed description of the male was given in my previous paper (Kormilev, 1956, p. 149), I repeat here only the comparative ratios.

MALE: Head shorter than wide through the eyes (male 17:24; female 16:25.5); anterior process relatively longer and narrower (20:13); the proportions of antennal segments (1 to 4) are: male 3:5:4:19; female 3:5:3:18; pronotum shorter than wide across the humeri (male 19:38; female 19:41); scutellum longer than wide at the base (male 49:33; female 51:36); abdomen shorter than wide (male 43:46; female 44:50).

SIZE: Total length: male, 3.00 mm., female, 3.34 mm. Width of pronotum: male, 1.24 mm.; female, 1.37 mm. Width of abdomen: male, 1.50 mm.; female, 1.67 mm.

HOLOTYPE: Male, Nova Teutonia, Santa Catarina, Brazil, Dec. 8, 1940, F. Plaumann; deposited in the collection of the author.

ALLOTYPE: Female, locality and collector same as for holotype, collected Dec. 1, 1940; in the collection of the author.

PARATYPES: One male and one female, locality and collector same as for holotype; one female, Porto Alegre, Rio Grande do Sul, Brazil, Rev. P. Buck, S. J.

REMARKS: *Calisiopsis brasiliensis*, new species, differs from *C. amplexes* Champion, 1898, principally in having a more robust and relatively wider body; relatively larger eyes that are placed much higher (seen from the front, two-thirds above the level of the vertex); and different proportions of the antennal segments.

References

CHAMPION, G. C.

1898. Rhynchota, in Godman and Salvin, *Biologia Centrali-Americana*, vol. 2, pp. xvi + 416, illus.

KORMILEV, N. A.

1956. Notas sobre Aradidae Neotropicales, VI (Hemiptera). Anal. Soc. Cient. Argentina, vol. 162, pp. 148-159, 1 pl.

MATSUDA, R., AND USINGER, R. L.

1957. Heteroptera: Aradidae. In, *Insects of Micronesia*, vol. 7, no. 3, pp. 117-172, 13 figs. Bernice P. Bishop Mus.

STÅL, C.

1860. Bidrag till Rio Janeiro-traktens Hemipter-fauna. K. Vet. Akad. Handl., vol. 2, no. 7, pp. 1-84.

PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



SMITHSONIAN INSTITUTION

U. S. NATIONAL MUSEUM

Vol. 109

Washington : 1959

No. 3414

FLIES OF THE GENUS *ODINIA* IN THE WESTERN
HEMISPHERE (DIPTERA : ODINIIDAE)

By CURTIS W. SABROSKY¹

The small acalyptrate genus *Odinia* Robineau-Desvoidy was long referred to the Agromyzidae, but is now generally placed in a separate family, the Odiniidae. Melander (1913, Journ. New York Ent. Soc., vol. 21, p. 248), in revising the North American Agromyzidae, gave a key to four species of *Odinia*, including one now referred to a different family. Otherwise, the genus has not been reviewed for the Western Hemisphere. The present paper includes nine species, five of them new. After this paper was prepared, I received a teneral female specimen from Beverly Hills, Calif., Aug. 5, 1958, Ben Osuna, that may represent a new species. It was collected in a Steiner fruit-fly trap. It is close to *meijerei*, but the wing spots are very distinct, those covering the crossveins especially broad and dark, and the midtibia has only a single strong bristle ventrally at the apex.

Six New World species are recorded in the literature: *picta* (Loew), described from Georgia; *williamsi* Johnson, described from the Galápagos Islands; *immaculata* Coquillett, described from New Hampshire; and three species described from Europe and recorded from North America, *boletina* (Zetterstedt), *ornata* (Zetterstedt), and *maculata*

¹ Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C.

(Meigen). Of these, *immaculata* is an agromyzid, a synonym of *Phytoliriomyza perpusilla* (Meigen). The specimen upon which the lone record of *ornata* was based (Tucker, 1909, Trans. Kans. Acad. Sci., vol. 22, p. 303) cannot be located, but the name should probably be eliminated from the New World fauna, at least until the status of true *ornata* in Europe is clarified. It has usually been considered a synonym of *maculata*, but the type has not been re-examined in the light of the latest revision of the Palaeartic species by Collin (1952, Proc. Roy. Ent. Soc. London, ser. B, vol. 21, pp. 110-116). *Odinia maculata* has been recorded from North America several times, but thus far I have not seen *maculata*, as elucidated by Collin, in North American material. At least three of the species recognized in this paper—*conspicua*, *meijerei*, and *betulae*—have been called *maculata* in older identifications.

The species of *Odinia* whose habits are known have been reared in association with wood-boring beetles or from trees attacked by such beetles, or, less commonly, by larvae of cossid or other moths. The larvae of at least one species were found in a *Polyporus* fungus, although this might also have been in association with the work of coleopterous larvae. In general, it appears probable that the larvae are saprophagous. Adult flies have been taken on *Polyporus* fungi, rotting stumps, tree trunks, and at bleeding wounds on trees. A new species from Puerto Rico and the Virgin Islands has been caught several times in fruit-fly traps.

Brues, Melander, and Carpenter (1954, Classification of Insects, ed. 2, p. 377) are in error in giving four dorsocentral bristles as a family character. The typical genus *Odinia*, which contains most of the species in the family, has five dorsocentrals (1 presutural, 4 postsutural). The other genera known to me—*Traginops*, *Schildomyia*, *Neoalticomerus*—have four.

In the present paper the figure numbers correspond to the species numbers, for the convenience of the user. The wings of all nine included species are figured. Specimens examined are in the U. S. National Museum (USNM), Canadian Department of Agriculture (CDA), American Museum of Natural History (AMNH), Museum of Comparative Zoology (MCZ), and the author's collection.

Genus *Odinia* Robineau-Desvoidy

Odinia Robineau-Desvoidy, 1830, Essai sur les Myodaires, p. 648. Two species, *trinotata* and *Peleterii*, both new. Type-species, *O. trinotata* R.-D. = *O. maculata* (Meigen), by designation of Rondani, 1875, Bull. Soc. Ent. Ital., vol. 7, p. 2.

The genus *Odinia* will key to the Agromyzidae in the family key in Curran (1934, Families and Genera of North American Diptera)

and will key correctly to genus in that family. Figure 4 on page 333 of that work illustrates the typical side view of the head of *Odinia*, and figure 2 the typical wing venation.

Generic diagnosis: Head bristles long and strong, with three pairs of orbitals, the posterior two reclinate, the anterior mesocline and cruciate at tips; both ocellars and postverticals widely divergent, the latter weaker than the other head bristles; inner and outer verticals strong; thoracic bristles equally strong, with 1 humeral, 1+1 notopleural, 1 presutural, 2 supraalar, 1 postalar, 5 dorsocentral, 1 pre-scutellar acrostical, 1 subapical and 1 apical pairs of bristles; mesopleuron bare; a short, fine propleural bristle present; 3 sternopleural bristles in a straight line, the anterior long, the others shorter; pre-apical dorsal bristle present on all tibiae, although short and weak; hind femur of male strongly incrassate; wing venation as figured in present paper, the costa broken at juncture of subcosta and ending at or slightly beyond third vein, anal vein and anal cell present. All species seem to have essentially the same color pattern on the legs (cf. description of *biguttata*), but the color varies considerably in extent. The two dark bands on the tibiae, one subbasal and the other apical, are quite regular.

Collin (1952) employs the presence or absence of small hairs on the parafrontals between the posterior orbital bristle and the verticals as one of the primary key characters in separating the species. I am inclined to mistrust this character, having seen the hairs present, present on one side only, and absent, in a series reared at the same time and place from the same "host," and certainly appearing to be the same species. However, presence or absence of the hairs may well be characteristic of a majority of individuals of a species, and I have utilized them to a certain extent.

Key to the New World species of *Odinia*

1. Wing with a few black spots on or enclosing veins, the wing membrane clear except in one species with two spots in marginal cell (figs. 1-4) 2
 Wing pattern reticulate, or with numerous dark spots most of which are surrounded by a whitish corona (figs. 5-8)..... 5
2. Marginal cell of wing clear, unspotted; mid tibia ventrally at apex with two strong bristles, subequal in length or unequal..... 3
 Marginal cell with two large, evenly spaced black spots between the smaller spots at junctures of first and second veins with costa; mid tibia ventrally at apex with only a single strong bristle..... 1. *O. biguttata*, new species
3. Mesopleuron gray, at most a streak or trace of brown posterodorsally; wing markings strong, the spots covering the fore and hind crossveins broad and dark, second and third veins with distinct brown clouds about their apices; antenna entirely yellow, at most the apicodorsal margin of third segment faintly browned; large species, typically the body and wing each 5 mm. long 2. *O. conspicua*, new species

- Mesopleuron dorsally with distinct broad brown stripe, continued on pteropleuron; spots on wing smaller, and apex of wing clear, the second and third veins not with brown clouds about their apices; antenna with at least a distinct, wedge-shaped black spot anterodorsally on third segment; smaller species, the body and wing each 2.5-4 mm..... 4
4. Hind crossvein narrowly and indistinctly, or not at all, infuscated, the fore crossvein only weakly so..... 3. *O. boletina* (Zetterstedt)
Both crossveins broadly and heavily infuscated, that on the hind crossvein usually broadening midway 5
5. Antennal segments 1 and 2 entirely yellow; upper orbit, between posterior orbital and the vertical bristles, usually with a few short black hairs on outer half 4. *O. betulae*, new species
Antennal segments 1 and 2, or at least the first, entirely or chiefly black; upper orbit bare of hairs..... 5. *O. meijerei* Collin
6. Wing pattern reticulate (fig. 6); face entirely yellow in ground color; second antennal segment yellow, rounded dorsally 6. *O. picta* (Loew)
Wing with numerous black or black-brown spots, most of them surrounded by a whitish corona (figs. 7-9); face broadly black to brown on upper two-fifths to half, from eye to eye; second antennal segment narrowly compressed and whitish on dorsal third to two-fifths..... 7
7. Vibrissa and one or two adjacent oral bristles distinctly flattened, the vibrissa broadly so on basal half..... 7. *O. williamsi* Johnson
Vibrissa and adjacent bristles slender, not unusually broadly flattened.... 8
8. Wing spots large and dark (fig. 8); second and third antennal segments each with large black mark on outer surface, and at least the third equally dark on most of inner surface; front relatively broad, obviously broader than long, and approximately twice the width of an eye; mesonotum without posteriorly bifurcate brown stripe..... 8. *O. coronata*, new species
Spots on wing small and pale (fig. 9); antennal segments almost entirely yellow; front relatively narrow, approximately square, and 1.4-1.5 times the width of an eye; mesonotum with narrow median brown stripe, posteriorly bifurcate, each half ending in a large brown spot beside fourth dorsocentral bristle 9. *O. parvipunctata*, new species

1. *Odinia biguttata*, new species

Species with two evenly spaced black spots in marginal cell.

Male. Unknown.

Female. Gray-black, heavily pollinose species; frontalia black, contrasting with the bright gray orbits and small frontal triangle, the ocellar tubercle and a spot about the base of each bristle subshining brown; narrow anterior margin of front, lunule, upper face and palpi yellow, the lower half of face and the cheek silvery white on yellow ground color; antenna yellow except for small fuscous spot on outside of second segment and small fuscous spots on inside and outside of third segment; arista yellow at base, the rest black; vibrissa, oral bristles, and postgenal hairs yellow to whitish yellow, all dorsal bristles black, but the anterior pair or two of orbital bristles yellowish distally. Thorax predominantly gray-black, the humeri and disk of scutellum yellowish; bristles and most of hairs set in shining brown spots; mesonotum anteriorly with narrow median

brown stripe, which forks opposite the third dorsocentral and continues caudad as two broad brown spots; mesopleuron with brown stripe above, and narrow broad margin adjacent to sternopleuron, the latter dark brown above; mesonotal bristles and hairs black, the sternopleural bristles pale distally, and propleural bristle yellowish. Abdomen gray, the numerous hairs and marginal bristles set on small brown spots; second tergum with broad brown band along hind margin, the third to fifth terga each with four brown spots, on the third tergum each submedian spot usually narrowly connected with the adjoining lateral spot. Legs predominantly yellow, more or less mottled with brown: Fore coxa yellowish, browned toward base; femora brown to blackish with some yellow areas, occasionally almost black except at knees, especially on outer surfaces of fore and hind femora; tibiae with subbasal and distal black bands, which vary somewhat in width and in depth of color; tarsi yellow, slightly browned toward apex. Wing hyaline, brown or black-brown spotted (fig. 1), with the usual spots on the veins and crossveins plus two spots in the marginal cell, and spots about the apices of second and third veins. Halteres whitish yellow.

Front relatively narrow, the breadth at vertex slightly greater than the length, 1.27 times the width of an eye and 0.40 times the width of the head, the anterior margin slightly concave, revealing the lunule; frontalia and anterior orbits with a few minute hairs, but none between the posterior orbital and the vertical bristles; vibrissa and oral bristles slender, not broadly flattened.

Middle tibia ventrally with only a single strong bristle, which is over half the length of the mid basitarsus; hind femur with one strong, partly or entirely yellow, preapical anteroventral bristle.

Length of body and of wing, 2.75–3 mm.

Holotype female (USNM 64272), Peter Rest, St. Croix, Virgin Islands, Oct. 13, 1956, R. Delgado. Paratypes, all females (USNM): 3, St. Croix, Virgin Islands, July 18, Sept. 15 (at Christiansted) and Sept. 29, 1956, Delgado; 1, St. Thomas, Virgin Islands, July 28, 1957, Delgado; 1, Isla Verde, Santurce, Puerto Rico, Oct. 9, 1956, A. L. Brown; 2, San Juan, Puerto Rico, May 17 and Aug. 8, 1953, B. B. Sugarman. All specimens were collected in fruit fly traps. I have also seen one female in poor condition, Miami, Fla., Jan. 24, 1957, H. N. McCoy, "in medfly trap."

The upper part of the face in some specimens shows a tinge of brown, and it is possible that normally the face is brown-banded as in the other Neotropical species. All available specimens were mounted out of fluid, and are probably paler than in life.

The wing pattern is the most distinct in the genus, and there should be no difficulty in recognizing the species. The single strong ventral

bristle on the mid tibia is also unusual in the genus, being found elsewhere only in *Odinia hendeli* Collin from Europe.

2. *Odinia conspicua*, new species

Large species with broad front, gray mesopleuron, and especially large and conspicuous spots on fore and hind crossveins of the wing.

Male: Chiefly gray-black; head yellowish gray, the lunule, face and cheek silvery gray, yellow in ground color; antenna, palpus, and proboscis orange yellow, the slender portion of arista brown; thorax black in ground color, bright gray pollinose, the humerus, and disk of scutellum except basally, yellowish; pleuron gray, only the sternopleuron slightly browned about bases of sternopleural bristles; abdomen gray with first two terga chiefly brown, four small and indistinct spots on terga three to five, and most hairs and bristles set in small brown spots; legs predominantly yellow, the fundamental pattern as described in *biguttata*, only weakly indicated; wing as in figure 2, the spots strong and black, those on crossveins especially strong and distinct, and dark clouds about the apices of second and third veins; all hairs and bristles black.

Front very broad, its breadth at vertex 1.2 times the length, 2.13 times the width of an eye, and slightly over half the width of the head, rather uniformly pollinose, the orbits and frontal triangle not clearly delineated, anterior margin strongly emarginate, revealing the large, semicircular lunule; each orbit with a few erect, black hairs on outer half between upper orbital bristle and the verticals; head in profile higher than long by 1.6 times, length at base of antenna 1.8 times that at vibrissa, the front sloping and the long axis of eye diagonal; cheek relatively broad, 0.42 times the height of an eye and 0.29 times the height of the head; vibrissa and oral bristles slender; antenna relatively small. Mid tibia with two strong, subequal apical ventral bristles; hind femur incrassate, 2.12 times as long as broad, with a strong, preapical anteroventral bristle followed by several weaker bristles; hind tibia shorter than hind femur; hind tarsus somewhat broadened distally. Third wing vein rather strongly arched.

Female: As described for male, but the hind femur not strongly incrassate, and anteroventral bristles stronger, with two bristles outstanding on distal third.

Length of body and of wing, 5 mm.

Holotype male (USNM 64273), "Jackson's Island," Md., July 3, 1911, P. R. Myers. Allotype (USNM), Atlanta, Ga., June 3, 1941, P. W. Fattig. Paratypes (all in USNM): male, same data as holotype;

male, Glen Echo, Md., July 4, 1921, J. R. Malloch (det. Malloch as *O. maculata* Meigen); male, Plummer's Island, Md., Aug. 3, 1915, at light, R. C. Shannon (det. Shannon as *O. picta* Loew); female, Springfield, Mass., Dimmock (No. 1841a).

The type locality, an island in the Potomac River a few miles above Washington, D. C., and slightly above Plummer's Island, is now called Turkey Island.

In addition to the above I have also seen two specimens in poor condition, a male from Glen Echo, Md. (same data as paratype), and a female from Springfield, Mass., Dimmock (No. 1843bb).

The two females reared by Dimmock were stated in his notes to be "parasites," and were reared under the following circumstances: No. 1841a, from tenebrionid larva (?*Scotobates*) under decaying bark of *Populus grandidentata*, the odiniid emerging from the beetle larva and pupating about May 8, 1901, and the adult fly emerging about June 5, 1901; No. 1843bb, from a number of tenebrionid larvae, apparently all *Scotobates calcaratus* (Fabricius), in decaying wood of *Populus grandidentata*, the fly larvae emerging and pupating May 23, 1901, and the flies appearing June 5, 1901.

This species is the largest that I have seen in the genus. It is distinguished from others with the same standard wing pattern by the combination of light colored body and broad, dark wing spots. In the revision of Palaearctic species by Collin (1952), it would appear to key to *O. xanthocera* Collin on the basis of the yellow antenna, but that species is described as much smaller (3 mm.), with a distinct brown stripe on upper mesopleuron, no upper orbital hairs, anteroventral spur on mid tibia only half the length of ventral spur, and the spots on the crossveins small and faint.

3. *Odinia boletina* (Zetterstedt)

Milichia boletina Zetterstedt, 1848, *Diptera Scandinaviae* . . . , vol. 7, p. 2721 (Sweden).

This species is characterized by the pale wing, the hind crossvein being indistinctly or not at all infuscated, and the other spots rather weak and indistinct. The upper part of the pleuron has a broad brown stripe, the upper orbits are bare, and the mid tibia ventrally has one long and one short apical bristles.

I have seen four females (in CDA) which agree with European material, and are recorded as *boletina*, at least pending further study by comparison of male genitalia: Hemmingford, Quebec, June 21, 1929, J. B. Maltais; Ottawa, Ontario, July 5, 1938, G. E. Shewell; Waterton, Alberta, July 13 and 15, 1923, H. L. Seamans.

4. *Odinia betulae*, new species

Species with chiefly yellow antenna, broad brown stripe on upper mesopleuron, and distinct spots on the wing veins.

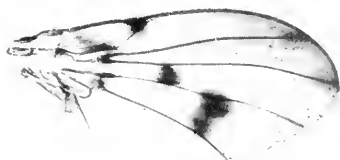
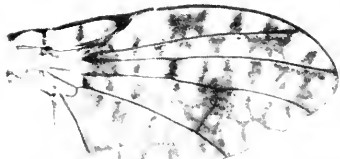
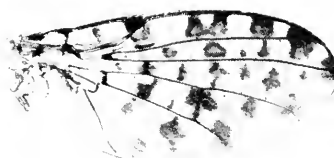
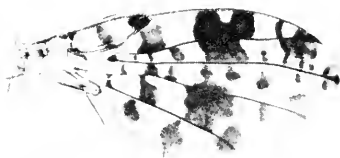
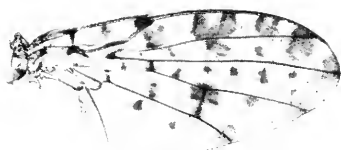
Male: Chiefly gray-black, a narrow anterior margin of front, antenna (except for wedge-shaped spot distad of the arista), base of arista, palpus, humerus indistinctly, scutellum faintly at apex, and legs in part, yellow; face and cheek silvery white on yellow ground color; mesonotum with two faint, irregular brown spots between the fourth dorsocentral bristles, and slight browning in upper angle of notopleuron; pleuron with two brown stripes, one across upper mesopleuron and pteropleuron, the other including upper sternopleuron and lower margin of mesopleuron; abdomen with brown bands on first and second terga, and four rounded spots on each of terga 3 to 5, the marginal bristles and many of the hairs set in small brown spots; legs variably marked with brown to blackish areas, the fundamental pattern approximately as described for *biguttata*; wing (fig. 4) with strong, black-brown spots; halter whitish yellow; all hairs and bristles black.

Front proportionately longer than usual, appearing almost square, and measuring barely wider than long, but the width at vertex twice the width of an eye and half the width of the head; orbits and triangle fairly distinct, bright gray pollinose compared with the black-gray of the frontalia; each orbit with a few erect black hairs on outer half, and usually a few between upper orbital bristle and the verticals; cheek comparatively narrow for the genus, at its widest two-fifths the greatest height of the eye and 0.28 times the height of the head; vibrissa and oral bristles slender; antenna relatively small. Acrostical setae in about six rows between the dorsocentral bristles. Mid tibia with two apical ventral bristles, the posterior weaker than the anterior and about two-thirds as long; hind femur greatly incrassate, only 1.8 times as long as broad, the hind tibia slightly shorter; hind tarsus somewhat broadened distally.

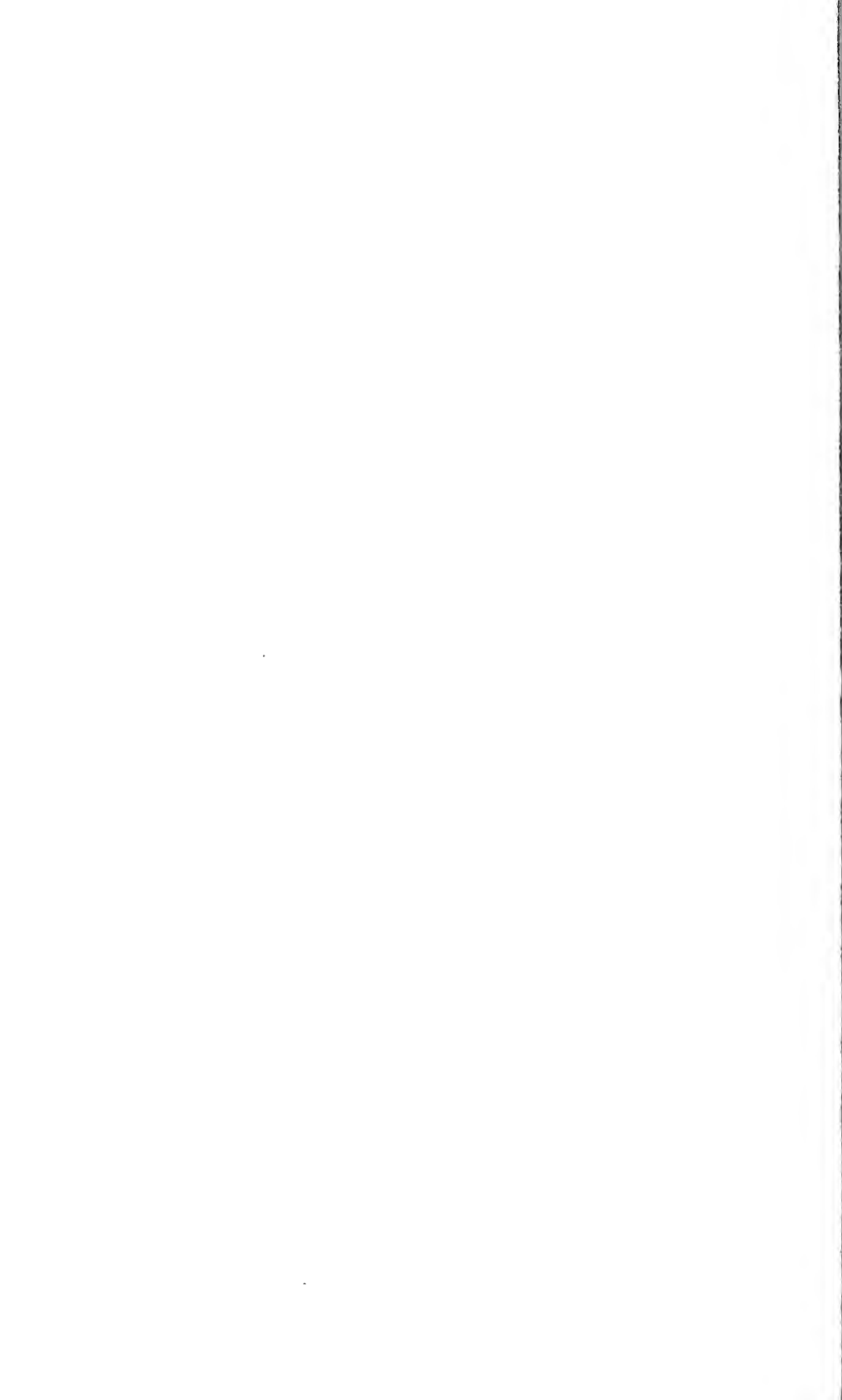
Female: As described for male, except as follows: Third antennal segment slightly but distinctly larger than in male; hind femur not greatly incrassate; hind tarsus ordinary, not broadened distally.

Length of body and of wing, 3.75–4.0 mm.

Holotype male (USNM 64274), China, Maine, reared Mar. 31, 1948. Allotype (USNM), Augusta, Maine, reared Apr. 1, 1948. Paratypes: 3 males (USNM), same data as holotype; female (USNM), same data as allotype; male (USNM), Strong, Maine, July 14, 1947; 2 males and 2 females (USNM), Bingham, Maine, July 9, 1947; 1 male and 3 females (USNM), Bingham, Maine, July 15, 1947; female (CDA), Trinity Valley, British Columbia, July 21, 1938, K. Graham; 6 males and 10 females (CDA), Laniel, Quebec, June 10, 1931, June 6,

**1****2****3****4****5****6****7****8****9**

Photographs of wings of species of *Odinia*: 1, *biguttata* (paratype, Santurce, Puerto Rico); 2, *conspicua* (holotype); 3, *boletina* (Waterton, Alberta); 4, *betulae* (male paratype, China, Maine); 5, *meijerei* (Harrisburg, Pa.); 6, *picta* (Montgomery Co., Pa.); 7, *williamsi* (Santa Cruz Island); 8, *coronata* (female paratype, La Unión, El Salvador), and 9, *parvipunctata* (male paratype, San Juan, Puerto Rico).



1933, and various dates from June 7 to July 21, 1934. The paratype from Strong, Maine, is labeled "Ex logs *Betula papyrifera*"; all other Maine specimens in the type series are labeled "Ex logs *Betula papyrifera* inf.[ested] by ambrosia beetles+*Agrilus anxius*." The Quebec specimens emerged in cages placed over felled white and black spruce, balsam, and white birch attacked by various beetles.

This species is close to *maculata* Meigen as defined by Collin (1952), but the latter is a much darker species, with the first and second antennal segments predominantly brownish or black, the dark area on third antennal segment extending to base of segment on outer surface, the thorax with narrow brown stripe on the midline and in each dorsocentral position, a distinct supraalar stripe, and the scutellum somewhat brownish about the middle. One European female before me, agreeing with Collin's diagnosis, is easily distinguished from the North American species.

Collin (1952, p. 116) refers to the association of *O. ornata* (Zetterstedt) with *Betula*, and believes that it will probably prove to be a distinct species when the type specimen has been studied. However, since the original description states that the basal antennal segments are black, it does not appear that the name *ornata* need concern us in connection with the Nearctic species found in association with *Betula*.

5. *Odinia meijerei* Collin

Odinia meijerei Collin, 1952, Proc. Roy. Ent. Soc. London, ser. B, vol. 21, pp. 112, 115 (England, Netherlands).

Limited European material of *meijerei* is available for comparison, but from this it appears that the species also occurs commonly in North America.

The detailed description given above for *biguttata* will serve well for *meijerei*, the chief difference being that the latter has the first two antennal segments, or at least the first, predominantly or entirely black, mesonotum chiefly gray pollinose, upper mesopleuron and pteropleuron with a broad brown stripe, marginal cell clear and unspotted, and membrane not clouded about the apices of second and third veins (fig. 5). The front is broad, slightly over twice the width of an eye and slightly over half the width of the head. The antenna in *meijerei* is notably larger and darker in the females than in the males. The mid tibia has two apical ventral bristles but the posterior is clearly shorter and weaker than the anterior.

Over 40 specimens are before me, chiefly from several localities in New York and Pennsylvania, reared in connection with studies on forest insects. Other available specimens are from Midland Co., Mich., June 11, 1939, R. R. Dreisbach (USNM); Dauphin Co., Pa., May 3, 1897 (USNM); lower Westchester Co., N. Y., May 22, 1934,

"reared elm sect.," A. P. Jacot (USNM); Galveston, Tex., Sept. 21, 1956, A. B. Beavers (USNM); Kearney, Arlington Co., Va., Oct. 2, 1912, F. Johanson (USNM); East Lansing, Mich., July 9, 1940, Sabrosky (author's collection); Nyack, N. Y., May 18-20, 1936, "from elm" (AMNH); Maynooth, Ontario, Sept. 5, 1953, and Ottawa, Ontario, May 29, 1955, both J. F. McAlpine (CDA). Four specimens from Westbury, Long Island, N. Y., A. B. Champlain, are probably the basis for the record of *Odinia maculata* published in "Insects of New York" (1928, p. 865).

The rearing records are not conclusive as to the feeding habits of the odiniid larvae, other than that they are associated with insect damage in trees. Most of the studies on forest insects referred to above recorded the flies as reared during studies of various beetles (*Scolytus*, *Saperda*, etc.) reared from dead or dying *Hicoria*. In one case (Westbury, N. Y.), the dipterous larvae and pupae were found in the primary egg galleries of *Scolytus quadrispinosus* Say, in *Hicoria*. Several specimens from Hendersonville, N. C., were reared from maggots found in a tulip tree in which the outer bark was infested with larvae of the phycitid *Euzophera ostricolorella* Hulst. The Ottawa example was labeled "on bleeding elm stump." Collin (1952) noted that in Europe *meijerei* "is to be found on diseased elm trees."

6. *Odinia picta* (Loew)

Milichia picta Loew, 1861, Berliner Ent. Zeitschr., vol. 5, p. 358 (Cent. 1, no. 99) (Georgia).

This species is adequately characterized in the key. It is unique in the genus in having a reticulated wing pattern. The brown areas are not definite spots surrounded by a whitish corona as in the Neotropical species *williamsi*, *coronata*, and *parvipunctata*. Unlike those species also, the face is yellow and the second antennal segment dorsally is not whitish and compressed.

I have seen only two specimens (MCZ)—the holotype, and a male from Montgomery Co., Pa., June 2, 1895, C. W. Johnson. The Pennsylvania specimen is apparently the one recorded as *picta* by Johnson (1910, Psyche, vol. 17, p. 235).

7. *Odinia williamsi* Johnson

Odinia williamsi Johnson, 1924, Zoologica, vol. 5, p. 90 (Galápagos Islands).—Curran, 1934, Families and genera of North American Diptera, p. 333, figs. 2, 4.

Species with numerous large dark spots on wing and broadly flattened vibrissae.

Gray-black, the narrow anterior margin of front, lunule, palpi except apices, humeri, and the apex, sides and venter of scutellum

yellow; whole front rather evenly gray pollinose, the orbits and frontal triangle not sharply distinct; upper half of face broadly seal brown from eye to eye, the lower half silvery white on yellow ground color; second antennal segment black, the dorsal two-fifths compressed and whitish, third antennal segment with broad black stripe on both inner and outer surfaces; arista black, yellow basally; mesonotum with irregular brown spots about bases of bristles, and smaller spots about bases of hairs, but no median brown stripe, the spots especially large about bases of second to fourth pairs of dorso-centrals; mesonotum anterolaterally on each side with a weak brown stripe mesad of humerus and extending caudad to notopleuron through base of presutural bristle; mesopleuron gray above, or with faint trace of brown near posterodorsal angle, but not with brown stripe; lower rim of mesopleuron and upper margin of sternopleuron dark brown; second abdominal tergum without a brown band, and the four brown spots on each of terga 3 to 5 small, rounded, and well separated from each other; legs about as described for *biguttata*; wing as in figure 7, with numerous black or black-brown spots scattered over the wing, most of them outlined by a white corona caused, at least in part, by fewer and paler microtrichiae in the surrounding membrane; halteres whitish yellow. All bristles and hairs black.

Front at vertex broader than long, twice the width of an eye and half the width of head, with a few fine hairs on the frontalia and lower orbits but none between the posterior orbital and vertical bristles; vibrissa short, strongly curved, broadly flattened on basal half, the adjacent orbital bristle or two likewise broadened basally. Mid tibia with two strong, subequal apical ventral bristles; hind femur with one strong, preapical, anteroventral bristle. Length of body and of wing, 3–3.5 mm.

I have seen the following material: 4 females (USNM), Isla Santa Cruz, Galápagos, 1948, K. Vinton; male (AMNH), Wollebaek Galápagos-Expedition, 1925; male and female (AMNH), Barrington Island, Galápagos, Oct. 20, 1925, F. X. Williams.

The specimens agree with the original description in all details except in having five pairs of dorsocentral bristles, the normal number for the genus, whereas the description said four pairs. This was undoubtedly an error.

The figures of *williamsi* by Curran are approximately correct, but the figure of the head fails to show the broad flattening of the vibrissa and one or two oral bristles, and also lacks strong divergent post-verticals. In the specimens before me, the wing shows whitish areas around the dark spots over the whole wing, and not merely along the posterior margin, as shown in the figure.

The flattened vibrissae of this species are apparently unique in the genus.

8. *Odinia coronata*, new species

Species with numerous large dark spots in wing, and slender vibrissae.

Male: Color as described for *O. williamsi* except as follows: Lower portion of second antennal segment with black stripe on outer surface, but inner surface reddish; mesonotum with brown spots about bases of bristles and hairs, and a large, irregular brown spot encompassing and mesad to the base of each fourth dorsocentral bristle, but no median brown stripe; in darkest specimens a brown stripe on each side of mesonotum mesad of humerus and extending caudad through bases of presutural and supraalar bristles to the postalar bristle; mesopleuron predominantly gray, dorsally with a narrow brown stripe, sometimes only a trace of brown; wing pattern (fig. 8) similar to that of *williamsi* but darker, the median spot in marginal cell and that encompassing the hind crossvein conspicuously larger and darker.

Front slightly narrower than in *williamsi*, 1.77 times the width of an eye and 0.47 times the width of head, with a few minute hairs as in *williamsi*; vibrissa long and slender, the adjacent oral bristles slender and almost hairlike. Mid tibial apical bristles as in *williamsi*; hind femur incrassate as usual in males, but not unusually so, the length 2.07 times the greatest diameter; hind tibia as long as hind femur; the latter with one strong preapical anteroventral bristle.

Female: As described for male, except for the following: Front broader, 1.3 times its own length, twice the width of an eye and one-half the width of the head; hind femur not enlarged.

Length of body and of wing, 3.5 mm.

Holotype male (USNM 64275) and allotype, La Union, El Salvador, Jan. 25, 1957, P. A. Berry (no. 807). Paratypes (in USNM): 2 females, same data as holotype; male, La Campana, Panama, January-March 1938, James Zetek; male, Palm Beach, Panama, Sept. 17, 1952, light trap, F. S. Blanton; female, Harlingen, Tex., Aug. 8, 1931, R. L. Clayton; female, Allen, Tex., Aug. 14, 1931, F. O. Swan. I have also seen two males in poor condition, not included in the type series, one with same data as the holotype and one with same data as the paratype from Allen, Tex.

This species is a near relative of *O. williamsi* from the Galápagos Islands. The form of the vibrissae is the only difference of consequence.

9. *Odinia parvipunctata*, new species

Species with numerous small spots in the wing, and slender vibrissae.

Male: Gray-black, the narrow anterior margin of front, lunule, palpi, antennae except narrow black spot on outside of second antennal segment and traces of brown on both inner and outer surfaces of third segment, humeri, scutellum except central area of disk, and halteres yellow; orbits and frontal triangle bright gray pollinose, fairly distinct from the gray-black frontalia; upper half of face light brown, lower half and cheek silvery white on yellow ground color; mesonotum with large brown spots about bases of bristles and smaller ones about hairs, plus a median, posteriorly bifurcate brown stripe, each fork forming a large spot mesad to the fourth dorsocentral bristle and sometimes extending back to the fifth dorsocentral, and a lateral brown stripe extending from mesad of the humerus to the mesonotal suture through the base of the presutural bristle, sometimes extending caudad through the bases of the supraalar bristles; mesopleuron with narrow, dark brown stripe just below notopleuron; lower rim of mesopleuron and the sternopleuron dorsally broadly brown-black; abdomen gray, with four moderately large, irregularly rounded brown spots on each of terga 3 to 5, and most of the hairs and marginal bristles set in small brown spots; legs approximately as described for *biguttata*, but consistently darker, the fore coxae entirely black-brown, the fore and hind femora likewise except at knees; wing (fig. 9) with small brown spots, most of them surrounded by a whitish corona, the spots smaller and paler than in *williamsi* or *coronata*. All bristles and hairs black.

Front relatively narrow, nearly square or very slightly broader than long, the width at vertex 1.4–1.5 times the width of an eye and barely over two-fifths the width of the head; frontalia and lower orbits with a few fine hairs, but none between the posterior orbital and vertical bristles; vibrissa long and slender, adjacent orbitals slender and almost hairlike. Mid tibia with two strong, apical ventral bristles, but the anterior somewhat shorter than the posterior; hind femur incrassate, 2.15 times as long as the greatest diameter, with one strong preapical anteroventral bristle; hind tibia subequal in length to hind femur.

Female: As described for the male, but the hind femur not as enlarged, 2.33 times as long as broad.

Length of body and of wing, 3.5 mm.

Holotype male (USNM 64276), Guajataca Forest, Isabela, Puerto Rico, July 22, 1955, at light, J. A. Ramos and J. Maldonado Capriles.

Allotype (USNM), St. Thomas, Virgin Islands, Dec. 21, 1957, fruit fly trap, R. Delgado. Paratypes (USNM), all Puerto Rico: male, Río Piedras, Aug. 18, 1932, Sein and Wolcott; female, Ramey Air Force Base, Apr. 2, 1957, insect trap, W. R. Fyke; male and female, San Juan, Aug. 8 and 17 (♂), 1953, fruit fly trap, B. B. Sugarman.

The many-spotted wing of this species is similar in pattern to that of *williamsi* and *coronata*, but the spots are consistently smaller and paler. It differs from both of those species in having a narrower front, in which character it resembles the smaller species *biguttata*, which is also found in Puerto Rico and the Virgin Islands. The latter is of course easily distinguished by the few spots in the wing.



PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



SMITHSONIAN INSTITUTION

U. S. NATIONAL MUSEUM

Vol. 109

Washington : 1959

No. 3415

BITING MIDGES OF THE GENUS *CULICOIDES*
FROM PANAMA (DIPTERA : HELEIDAE)

By WILLIS W. WIRTH¹ and FRANKLIN S. BLANTON²

Introduction

In 1951 the junior author began a 3-year assignment as entomologist to the U. S. Army Caribbean at Fort Clayton in the Panama Canal Zone. During this assignment surveys for blood-sucking insects, which were begun at military installations in the Canal Zone and various maneuver areas, were extended to cover a wide area over the Republic of Panama (Blanton, Galindo, and Peyton, 1955). The senior author determined the *Culicoides* that were collected and he cooperated in describing the numerous new species that were soon discovered. Some of these new species were described in joint papers as the work progressed, but it was soon realized that a major revision of the Panama species was needed, and we then devoted our efforts to the present paper.

When our studies began, 16 species of *Culicoides* had been reported from Panama (Fairchild, 1943; Barbosa, 1947; Fox, 1947; Ortiz, 1950a). By intensive collecting, primarily with light traps, the number has been increased to 88. By additional collecting in selected

¹ Entomologist, Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C.

² Lieutenant Colonel, MSC. Retired. Formerly at Department of Entomology, Walter Reed Army Institute of Research, Washington, D. C.

localities such as the eastern Darien Mountains, the Chiriquí highlands, the southern Chiriquí gallery forests, and the Caribbean rain forests, and by a special program of collecting and rearing from larval habitats we believe this number can be materially increased. This phenomenal number of species of a single genus in an area as small as the Republic of Panama is a result of the ecological diversity of this mountainous country (Goldman, 1920; Standley, 1928; Kenoyer, 1929) and of its peculiar geographic position. As an isthmus between two continents Panama has received species that have been stranded from waves of migrations of historical faunas from north to south and from south to north during geological periods of time (Chapman, 1917; Schuchert, 1935; Griscom, 1935, 1940, 1950).

For their generous cooperation and assistance in making the field collections and sorting specimens in Panama, we are greatly indebted to the following persons and organizations: Col. Francis P. Kintz, Surgeon, and Lt. Col. Edward J. Dehne, Chief of Preventive Medicine, U. S. Army Caribbean, and the personnel of the 25th Preventive Medicine Survey Detachment; the Gorgas Memorial Laboratory, especially Dr. Pedro Galindo, Dr. G. B. Fairchild, and Dr. Harold Trapido; and the Inter-American Geodetic Surveys, especially Mr. Elton Vickers.

We particularly thank Mr. Gordon A. Marsh, of the University of California, for making the many thousands of measurements of specimens, a laborious task performed as a technician at the Walter Reed Army Institute of Research.

The illustrations accompanying this paper were made by Miss Sakiko Asano, Mr. Kei Daishoji, Mr. Akira Shimazoe, and Miss Kazuko Tsukamoto of the 406th Medical General Laboratory, U. S. Army in Tokyo, Japan, under the direction of Mr. Kakuzo Yamasaki, and by Mr. Thomas M. Evans, scientific illustrator of the Walter Reed Army Institute of Research, Washington, D. C. The Japanese artists were under the direction of Maj. Hugh L. Keegan, MSC, Department of Entomology, and Col. Joe M. Blumberg, MC, Commanding Officer of the 406th Medical General Laboratory.

For taxonomic advice and cooperation, including frequent exchange of specimens and manuscript notes, we thank our co-workers on the taxonomy of American *Culicoides*: Dr. O. P. Forattini of the Universidade de São Paulo, Dr. Irving Fox of the University of Puerto Rico, and Dr. Ignacio Ortiz-Cordero of the Instituto Nacional de Higiene of Caracas, Venezuela. We are indebted to Dr. A. da Costa Lima of the Instituto Oswaldo Cruz for the loan of type material from the Lutz collection, to Dr. Irving Fox of the University of Puerto Rico for the loan of numerous type specimens described by himself and Dr. W. A. Hoffman, and to Mr. Paul Freeman and the trustees of the British

Museum (Natural History) and to Dr. Alan Stone of the U. S. Department of Agriculture for assistance on the types of Williston and Macfie. Dr. P. A. Woke of the U. S. Public Health Service and Dr. L. E. Rozeboom of Johns Hopkins University also furnished Panama material for study, including some specimens from field collections which in part formed the type series of new species described by Fox (1947) and Barbosa (1947).

ECONOMIC IMPORTANCE

The role of *Culicoides* biting midges as vectors of pathogenic organisms has hardly been investigated enough to give any index of their potential importance, but it seems likely that their role is minor compared with that of mosquitoes, fleas, lice, and ticks. However, studies already made indicate that *Culicoides* may play an important role in disease transmission, principally as vectors of filarial worms (Buckley, 1934, 1938; Chardome and Peel, 1951; Dampf, 1936; Henrard and Peel, 1949; Hopkins, 1952; Hopkins and Nicholas, 1952; Mirsa, Mirsa, and Ortiz, 1952; Steward, 1933) and of certain groups of viruses such as bluetongue of sheep (du Toit, 1944; Price and Hardy, 1954) and fowlpox (Tokunaga, 1937).

By their annoying attacks in tremendous numbers, *Culicoides* can make life almost unbearable in areas where certain anthropophilic species occur. The most pestiferous American species is *Culicoides furens* (Poey), which in some coastal areas is troublesome enough to retard the development of otherwise favorable resorts (Adamson, 1939; Dove, Hall, and Hull, 1932; Myers, 1935; Painter, 1926). This species is a pest along the Panama coasts. At Fort Kobbe in the Canal Zone women and children frequently request medical treatment for secondary infections resulting from *Culicoides* bites. *C. furens* is doubly annoying because it is one of the few species of *Culicoides* that will readily enter houses, and the females are so small that ordinary or untreated window screens are no barrier to them.

The importance of *Culicoides* and other small, hairy members of the Heleidae as pollinators of tropical economic plants has only recently been discovered. Posnette (1944) found that heleid midges are the chief pollinators of cacao in Trinidad, and Warmke (1951, 1952) that they are the most important pollinators of the Pará rubber tree in tropical America. Included among the known rubber pollinators are *C. diabolicus* Hoffman and *C. jamaicensis* Edwards (Wirth, 1956).

GEOGRAPHY AND CLIMATE IN PANAMA

GEOGRAPHY (Goldman, 1920; Schuchert, 1935): Panama, the southernmost of the Central American republics, lies at the narrowest

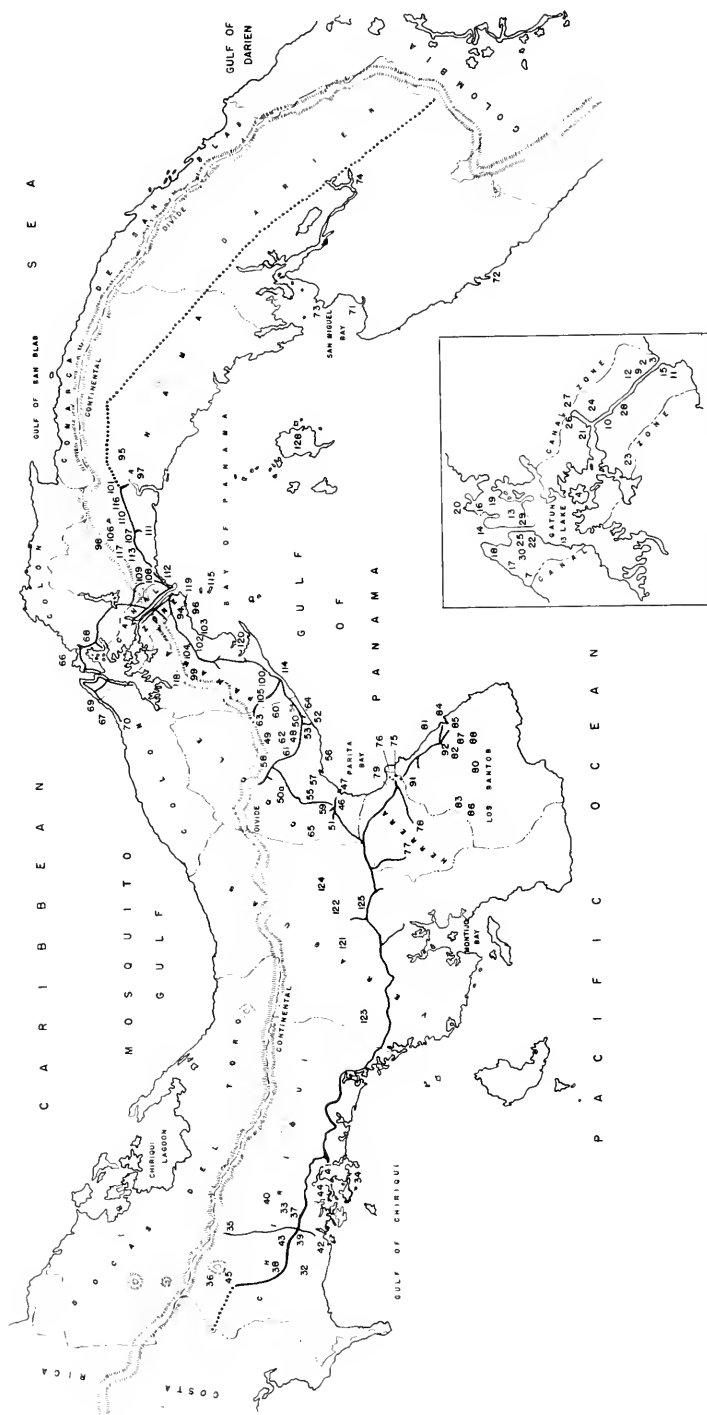


FIGURE 1.—Map of the Republic of Panama and the Canal Zone (insert). Names of numbered localities are listed on facing page (below).

EXPLANATION OF FIGURE 1.—Numbered localities from which specimens of *Culicoides* have been collected. Numbers and localities in parentheses are not shown on the map.

Bocas del Toro Province	53. Hato, Río	77. Ocu	103. Chorrera, Puerto
1. Almirante	54. Hermita	78. Pesé	104. Coco, El
Canal Zone	55. Natá	Los Santos Province	105. Espino, El
2. Ancón	56. Obaldía, Puerto	79. Cruces, Las	106. Goofy Lake
3. Balboa	57. Pasado, Puerto	80. Estibaná, Río	107. Jolla, La
4. Barro Colorado Island	58. Penonemé	81. Guararé	108. Juan Díaz
(5. Cabima)	59. Pocrí	82. Lajas, Las	109. Lajas, Río Las
(6. Camp Butler)	60. Retiro, El	83. Macaracas	110. Naranjal
7. Camp Piña	61. Salado, El	84. Mensabé, Puerto	111. Pacora
(8. Cano Saddle)	62. Tranquilla	85. Palma, La	112. Panamá Vieja
9. Corozal	63. Valle, El	86. Pan de Azúcar	113. Pedregal
10. Empire	64. Venta, La	87. Peña Blanca	114. San Carlos
11. Farfan Beach	65. Yeguada, La	88. Quemado	115. Taboga, Isla
12. Fort Clayton	Colón Province	(89. San José)	116. Tapagra
13. Fort Davis	66. Cativá	(90. Santo Domingo)	117. Tocumen
14. Fort Gulick	67. Nuevo Chagres	91. Santos, Los	118. Trinidad, Río
15. Fort Kobbe	68. Pilón	92. Tablas, Las	119. Venado Beach
16. Fort Randolph	69. Piña	Panamá Province	120. Vique Cove
17. Fort San Lorenzo	70. Salud	(93. Alcalde Díaz)	VERAGUAS PROVINCE
18. Fort Sherman	Darién Province	94. Arraiján	121. Divisa
19. France Field	71. Garachiné	95. Bayano	122. Río Santa María
20. Galeta Point	72. Jaqué	96. Camarón	123. Palmas, Las
21. Gamboa	73. Patiño, Punta	97. Capitana	124. San Francisco
22. Gatón	74. Real, El	98. Cerro Azul	125. Santiago
23. Huile Sia Clara (?)	Herrera Province	99. Cerro Campana	ARCHIPIÉLAGO DE LAS
24. Las Cruces	50. Chirú, El	100. Chame	PERLAS
25. Loma Boracho	50a. Coelé	101. Chepo	126. Rey de San Miguel,
26. Madden Air Strip	51. Cristo, El	102. Chorrera, La	Isla del
27. Madden Dam	52. Farallón, Puerto		

eastern portion of the Isthmus of Darién adjacent to the South American Republic of Colombia (fig. 1). Panama is about 400 miles long from east to west, and its width varies from less than 50 miles at the Canal to about 125 miles at the Azuero Peninsula east of the Canal Zone. The northern, or Atlantic, coast forms a flattened S-shaped curve, undented except for the Chiriquí Lagoon at the west. The southern, or Pacific, coast line is very irregular, with several peninsulas and bays, the eastern part forming an arc around the Gulf of Panama. A number of islands lie off the coasts. Panama has an area of over 34,000 square miles and ranges in altitude from sea level to 11,500 feet in the Volcán region near the Costa Rican border. A number of mountain ranges form the backbone of the Isthmus of Panama, with low passes between, the lower ones located toward the central part of the country at the Canal Zone. From west to east the principal mountain ranges are the Volcán de Chiriquí (11,500 feet) and the Serranía Tabasará (9,200 feet) west of the Canal Zone and the Cordillera de San Blas (2,900 feet) and the Serranía del Darién (7,500 feet) closely bordering the Atlantic coast to the east. The upper slopes of the mountains are steep but not precipitous, gradually merging into hilly country below with numerous narrow river valleys separated by narrow, greatly eroded ridges. Extensive plains are found at various elevations in Chiriquí Province and on the Pacific coast from Chepo west to the Canal Zone. The larger rivers flow into the Pacific, the principal ones being the Tuira-Chucunaque in Darién Province and the Chepo-Bayano in Panamá Province; the Chagres River drains a wide area near the Canal Zone and originally flowed into the Atlantic, but now is impounded in Madden and Gatún Lakes and flows through the locks of the Panama Canal into both oceans.

CLIMATE (Goldman, 1920; Kenoyer, 1929; Arnett, 1950): Lying between the latitudes of 5° and 10° North, the Republic of Panama has a tropical climate in the strict sense, with temperatures at sea level the year around of about 90° F. during the day and 70° F. at night. Temperature varies with altitude, and thus some of the higher mountains are temperate. The annual cycle is made up of two seasons, the wet and the dry. During the wet season, from May to December, the prevailing wind is from the south, and rains are frequent and widespread throughout the country. During the dry season, from December to May, the prevailing wind shifts to the north, and while the northern slope of the country receives frequent light rains, the southern slope lying in the rain shadow of the mountains receives very little precipitation.

LIFE ZONES IN PANAMA

There are three principal life zones in the Republic of Panama—tropical, subtropical, and temperate (Goldman, 1920; Griscom, 1935).

The tropical zone covers nearly the entire country except for some elevations above 3,000 to 3,500 feet. It is divided by rainfall differences into two sections, the humid tropics (lowland rain forest) on the entire Atlantic slope and on the Pacific side of eastern Darien, and the arid tropics (arid deciduous forest and savanna) on the remaining Pacific slope.

In the humid tropical zone the annual rainfall ranges up to 150 inches, and although it comes mostly in the wet season, enough falls regularly in the dry season to support an evergreen or rain forest (Standley, 1928). Plants forming the characteristic vegetation include the star-apple (*Chrysophyllum*), wild fig (*Ficus*), almendro (*Dipteryx panamensis*), maragua (*Poulsenia armata*), and many palms, aroids, heliconias, and lianas. Characteristic mammals are tapirs, monkeys, cats, opossums, squirrels, and arboreal anteaters and sloths.

In the arid tropical zone the rainfall is less, about 85 inches in the wet season, and the long drought causes the forest to turn brown and lose its leaves except in the stream valleys. In western Panama there are, or were before deforestation by man, extensive areas of open or gallery forest along the coastal border, with trees of impressive size. Farther inland there is a belt of low scrub forest interrupted by areas of open grassland or savannas, which are frequently burned over during the dry season. Farther up the slopes of the mountains the forest reappears and becomes better developed. In eastern Panama, merging into the Pacific or South American rain forest, there is a different type of gallery forest, such as that in the Tuyra River valley, called by Griscom (1935) the cuipo forest, with a fauna all its own. Plants characteristic of the arid tropics of Panama are the guarumo (*Cecropia arachnoides*), cuipo (*Cavanillesia*), cocobola (*Dalbergia retusa*), Spanish cedar (*Cedrela*), guava (*Psidium guajava*), mesquite (*Prosopis*), cacti, and many grasses and sedges. Characteristic mammals include peccaries, forest rabbits, foxes, and deer.

The subtropical zone (montane rain forest) comprises the upper slopes and crests of the mountains between 3,000 and 8,500 feet elevation, only the Volcán de Chiriquí rising above this zone. This zone is forested, with many palms and tree ferns, the trees being generally smaller than in the tropical zone, with great variations in kinds due to slope exposure. Precipitation and fogs in a cloud belt

due to condensation from the northeast trade winds are features of this zone. The subtropical zone is extensive in the Chiriquí highlands and in the two mountainous spurs of the Andes near the Colombian border. Characteristic plants include *Podocarpus*, oaks, palms, and many ferns, epiphytes, and lianas.

The temperate zone (temperate forest) is confined to the summit of the Volcán de Chiriquí above 8,500 feet elevation. Decrease in moisture and lower temperatures, dropping to below freezing, result in a stunting of the vegetation (pygmy forest) and a heavy overgrowth of moss and lichens. Low ericaceous and myrtaceous shrubs become dominant, among them *Dendrophthora* spp., *Arcytophyllum lavarum*, and *Maytenus woodsonii*.

DISTRIBUTION OF CULICOIDES BY LIFE ZONES

We can make only tentative lists of the species of *Culicoides* characteristic of each life zone, principally because so many of the localities are not completely typical of a zone and most of the collections were not made under optimum conditions in each zone.

We have chosen the localities of Almirante and Mojanga Swamp as fairly typical of the humid tropical rain forest on the Atlantic side, and the localities of Tocumen and Aguadulce as typical of the arid tropical savanna country on the Pacific coast. All four of these localities have the complication of proximity to coastal salt marshes with a representation of salt marsh species.

The contrast, however, in the relative abundance of the species found in these two types of environment is evident from table 1. From the table it will be seen that when the salt marsh species (see the following paragraph) are excluded, only six species are common throughout the tropical zone: *debilipalpis*, *diabolicus*, *dicrourus*, *galindoi*, *hylas*, and *leopoldoi*. Seven species are abundant in the humid tropics but absent in the arid tropics: *acotylus*, *castillae*, *fluvialis*, *paraensis*, *proppriipennis*, *pusilloides*, and *uniradialis*. Only one species, *insignis*, is abundant in the arid tropics cow-pasture country but absent in the Almirante and Mojanga rain forests. Almirante has three abundant species—*elutus*, *nigrigenus*, and *panamensis*—not found at Mojanga, and Mojanga has only one abundant species, *caprilesi*, not found at Almirante. Of the rarer species, two—*ginesi* and *pusillus*—are found in all four localities, two—*jamaicensis* and *macrostigma*—are found in all but Aguadulce, and one—*fori*—is found in all but Almirante. Twenty rare species were taken in the humid but not in the arid tropics: *antefurcatus*, *aureus*, *balsapambensis*, *camposi*, *carsiomelas*, *crescentis*, *daedaloides*, *gabaldoni*, *glabrior*, *lanei*, *mojangaensis*, *pachymerus*, *patulipalpis*, *pifanoi*, *pilosus*, *poikilonotus*, *spurius*, *tenuilobus*, *tetrathyris*, and *verecundus*. Four-

teen additional rare species were found only at Almirante: *almirantei*, *azureus*, *commatus*, *covagarciai*, *daedalus*, *lyrinotatus*, *marshi*, *metagonatus*, *mirsaе*, *pampoikilus*, *phaeonotus*, *rangeli*, *scopus*, and *transferrans*. only six rare species were found at Mojinga only: *alahialinus*, *carpenteri*, *guyanensis*, *imitator*, *limai*, and *stigmatis*.

TABLE 1.—Approximate maximum numbers of specimens of Culicoides collected per trap night in light traps in humid and arid areas of Panama

Species	Humid tropics		Arid tropics	
	Almirante	Mojinga	Tocumen	Aguadulce
diabolicus	1000	50	100	1000
insignis	—	—	100	1000
hylas	100	25	1	—
leopoldoi	100	50	50	—
dicerourus	50	1	1	—
propriipennis	50	1	—	—
furens	10	50	10	1
reticulatus	1	50	—	—
iriartei	25	1	—	—
pusilloides	25	1	—	—
wokei	—	20	—	—
galindoi	10	1	1	—
acotylus	10	1	—	—
elutus	10	—	—	—
fluvialis	10	1	—	—
castillae	10	1	—	—
nigrigenus	10	—	—	—
panamensis	10	—	—	—
paraensis	10	1	—	—
gorgasi	—	10	—	—
debilipalpis	1	10	—	1
caprilesi	—	10	—	—
uniradialis	1	10	—	—

From the lists given in the preceding paragraph the following ten tidal salt marsh species have been eliminated although they were occasionally recorded from some of the localities: *arubae*, *barbosai*, *furens*, *gorgasi*, *iriartei*, *phlebotomus*, *reticulatus*, *trinidadensis*, *willistoni*, and *wokei*. These species have never been recorded from inland localities, and their abundance at typical salt marsh localities is confirmed by the list of species taken in such habitats given in table 2.

Our lists of species characteristic of the higher elevations are doubtless incomplete owing to our small number of collections from

the temperate and subtropical life zones. We have found seven species—*chrysonotus*, *dunni*, *efferus*, *lutealaris*, *luteovenus*, *venezuelensis*, and *volcanensis*—confined in Panama to the Volcán region in the lower part of the temperate zone. We record seven species—*coragarciai*, *elutus*, *magnipalpis*, *metagonatus*, *pampoikilus*, *rostratus*, and *scopus*—as typical of the subtropical zone at Cerro Campana and El Valle, although some of these and three others—*nigrigenus*, *rangeli*, and *transferrans*—range from the Volcán down to the humid tropics at Almirante.

TABLE 2.—Comparison of maximum numbers of species of *Culicoides* characteristic of the Pacific coastal salt-marsh locations taken per night in light traps

Species	Darién Prov. (Garachiné)	Coclé Prov. (Puerto Farallón)	Herrera Prov. (Puerto Chitré)	Los Santos (Puerto Mensabé)
<i>trinidadensis</i>	1000	100	50	—
<i>furens</i>	50	50	200	300
<i>gorgasi</i>	50	50	20	10
<i>reticulatus</i>	50	50	—	25
<i>willistoni</i>	10	200	20	—
<i>phlebotomus</i>	10	50	—	—
<i>arubae</i>	—	—	500	1
<i>debilipalpis</i>	—	30	1	50
<i>iriartei</i>	1	1	1	50
<i>wokei</i>	1	20	10	—
<i>diabolicus</i> and <i>insignis</i>	10	50	100	30
<i>hylas</i>	1	10	—	1
<i>pusillus</i>	10	1	—	10
<i>camposi</i>	1	—	—	—
<i>caprilesi</i>	1	—	—	—
<i>dicrourus</i>	1	—	—	—
<i>gabaldoni</i>	—	—	—	1
<i>ginesi</i>	—	—	—	1
<i>imitator</i>	—	—	—	1
<i>jamaicensis</i>	1	1	1	—
<i>leopoldoi</i>	1	1	—	1
<i>paraensis</i>	—	1	—	1
<i>patulipalpis</i>	1	—	—	—
<i>pifanoi</i>	1	—	—	—
<i>uniradialis</i>	1	—	—	—

According to Chapman (1917), the fauna of the humid tropical rain forests of Panama is essentially an extension of the Amazon Basin fauna through the intervening rain forests of western Colombia and Ecuador. This Colombian-Pacific fauna was cut off from the

upper Amazon by the Andean uplift in the Tertiary period. Chapman also found a remarkable similarity in the subtropical bird fauna of Colombia to that of Costa Rica and western Panama, with about 60 species in common. He could explain this similarity only by postulating a former continuous extension of the Andes Mountain system at altitudes not less than 5,000 feet throughout Panama. The temperate avifauna of Costa Rica, on the other hand, is not closely related to that of Colombia, indicating that this mountain connection never exceeded a height of 9,000 feet. The subsidence of the Panama Isthmus to its present elevation in what Chapman called the Panama "fault," has resulted in the extinction of the subtropical fauna in the intervening area except for a few relicts such as the *Culicoides* we have reported from Cerro Campana and El Valle. The fauna of the arid tropical zone of Panama, according to Griscom (1935), is an extension of the Central American faunal subregion, and not closely related to that of South America, except for the gallery forest species, which find their relatives in the arid Dagua and Magdalena areas and the arid north coast of Colombia.

BREEDING PLACES

General accounts of the breeding habits of *Culicoides* are given by Carter, Ingram, and Macfie (1920) and Hopkins (1952) for West Africa; Hill (1947), Lawson (1951), and Kettle and Lawson (1952) for Britain; and Williams (1951) for North America. Little rearing work has been done on Neotropical *Culicoides*, the only important references being Lutz (1913), Painter (1926), Fox (1942), Carpenter (1951), and Woke (1954). The known breeding places of Panama *Culicoides* are given in table 3.

Favorite larval habitats include the following: mud and sand at stream, pond, and ditch margins or margins of practically any small body of still or slowly running water; compost piles, rotting leaf mold, and other vegetable matter that stays wet constantly. In the tropics larvae may be found in rotting banana stalks and wet, decaying fruits and stems of plants; mud or wet organic material in or at the sides of rot holes in trees, stumps, bamboo joints, coconut shells, rotten boat bottoms, and the like; wet debris in the leaf or flower axils of waterholding plants such as pitcher plants, aroids, bromeliads, *Heliconia*, and *Pandanus*; and crab holes. Picado (1913) showed heleid larvae that resemble *Culicoides* taken from bromeliads in Costa Rica. Ryckman and Ames (1953) reared *Culicoides copiosus* Root and Hoffman from rotting stems of the cactus *Cereus gigantea* in Arizona.

TABLE 3.—*Known breeding places of Panama Culicoides*

Species	Locality	Habitat (Authority or Collection Data)
<i>arubae</i>	Aruba, D. W. I.	Crab holes (Fox, 1942; Fox and Hoffman, 1944)
<i>castillae</i>	Barro Colorado I., C. Z.	Flowers of <i>Heliconia mariae</i> , June 1940, J. Zetek No. 4667 (USNM) Flowers of <i>Heliconia platystachys</i> , Sept. 1940, J. Zetek No. 4690 (USNM)
<i>furens</i>	Honduras	Sand and mud near tidal canal (Painter, 1926)
	Balboa, C. Z.	Tidal salt marsh (Carpenter, 1951; Woke, 1954; Blanton, Graham, and Keenan, 1955)
<i>heliconiae</i>	Venezuela	Bromeliads (Fox, 1942; Fox and Hoff- man, 1944)
	Honduras	Water holding plant (Fox, 1948)
	Trinidad	Flowers of <i>Heliconia elongata</i> (Wirth and Blanton, 1956a)
<i>hoffmani</i>	Puerto Rico	Tree hole debris (Fox, 1949)
<i>hylas</i>	Barro Colorado I., C. Z.	Bred from <i>Calathea violacea</i> (Wirth and Blanton, 1956a)
<i>jamaicensis</i>	Ancón, C. Z.	Reared from rotted calabash (Hoffman, 1925)
<i>luteovenus</i>	California	Tree hole, creek mud (Wirth, 1952a)
<i>panamensis</i>	Barro Colorado I., C. Z.	Flowers of <i>Heliconia mariae</i> , June 1940, J. Zetek No. 4667 (USNM)
<i>phlebotomus</i>	Honduras	Wet, low depressions behind sandy beach, water from seepage at high tide (Painter, 1926)
<i>pifanoi</i>	Barro Colorado I., C. Z.	Flowers of <i>Heliconia mariae</i> , June 1940, J. Zetek No. 4667 (USNM)
<i>pusillus</i>	Brazil	Mangrove mud (Lutz, 1913)
<i>reticulatus</i>	Brazil	Crab holes (Lutz, 1913)
<i>trinidadensis</i>	Balboa, C. Z.	Tidal salt marsh near mangrove (Woke, 1954)
<i>verecundus</i>	Barro Colorado I., C. Z.	Bracket fungus, Aug. 1944, J. Zetek No. 5175 (USNM)

BITING HABITS

Lutz (1913) in Brazil took *Culicoides reticulatus* and *insignis* on man, horse, and cow; *pusillus* on man; *paraensis* on man; and *debilipalpis* on man and horse. Painter (1926) found the pestiferous species at Puerto Castilla, Honduras, to be *furens* and *phlebotomus*. Adamson (1939) found the following species in Trinidad to bite man (named in order of their importance): *phlebotomus*, *diabolicus*, *guyanensis*, *furens*, and *debilipalpis*.

Gibson and Ascoli (1952) reported on the anthropophilic *Culicoides* in the human onchocerciasis zone of Guatemala near San Pedro Yepocapa: *C. paraensis* was the dominant and most annoying species, biting at any hour and in any weather; *castillae* fed under the same conditions as *paraensis* but was rare; neither of these species could ingest microfilariae. *C. stigmatis* bit frequently between 4:30 and 6 p. m. when the sky was partly overcast, but this species was not abundant, and although it could ingest microfilariae, they did not develop. *C. diabolicus* bit only during or immediately after a light rain, and did not feed as avidly on man as the others; no good test was possible on its ability to ingest and support microfilariae. No natural filarid infestation was found in 929 wild flies of these four species.

Woke (1954) at Balboa, Canal Zone, collected *furens* biting man in sunlight and in shade of mangrove trees, under electric lights and also in darkness, from 9 a. m. to 9 p. m. He collected *guyanensis* biting man between 7 and 8 p. m., *trinidadensis* about man, and *wokei* flying about man in shade of mangrove trees and in full sunlight between 9 and 10 a. m. On Tobago Island he took *furens*, *paraensis*, and *debilipalpis* biting man, and at Corinto, Nicaragua, he collected *furens* and *phlebotomus* on man.

Wirth (1955b) reported the following Panama species from the collections of Gibson and Ascoli in Guatemala taken while biting man: *paraensis*, *pachymerus*, *stigmatis*, *diabolicus*, *castillae*, and *debilipalpis*. At the same time Gibson and Ascoli took *luteovenus*, *diabolicus*, *debilipalpis*, and *panamensis* feeding on horse and mule.

In the U. S. National Museum collection there are the following unpublished records of Panama species taken on man: *barbosai*, Balboa, Canal Zone, P. A. Woke, No. 1014a; *diabolicus*, St. Patrick Estate, Trinidad, 1954–1955, T. H. G. Aitken and W. G. Downs; *pusillus*, Cumaca, Trinidad, June 16, 1954, Aitken and Downs; and of the following species biting other animals: *arubae*, Corazal, Canal Zone, May 18, 1914, S. T. Darling, from ear of mule; *fori*, Fort Kobbe, Canal Zone, Blanton, horse trap; Piraja, Brazil, Apr. 16, 1929, Davis and Shannon, animal bait; *barbosai*, Fort Randolph, Canal Zone, Blanton, horse trap.

In summary, the following species of Panama *Culicoides* are known to feed on man: *barbosai*, *castillae*, *debilipalpis*, *diabolicus*, *furens*, *guyanensis*, *pachymerus*, *paraensis*, *phlebotomus*, *pusillus*, *reticulatus*, and *trinidadensis*.

CONTROL MEASURES

The control of *Culicoides* has received little attention in Panama compared with the classic measures used to abate mosquitoes during and since the construction of the Panama Canal. Carpenter (1951)

and Blanton, Graham, and Keenan (1955) gave details on efforts to control the enormous population of *Culicoides furens* (Poey) at Fort Kobbe, which adjoins Farfan swamp on the west bank of the Pacific entrance of the Canal. The most successful measure was the installation of tide gates at the mouth of the Farfan River in August 1950. After the rainy season had passed, by February 1951, the action of these gates in eliminating salt water from the marshes caused the water level to recede to the deeper ditches and channels. This change resulted in the growth of luxuriant vegetation on the drier ground and a great reduction in the *Culicoides* population. The tide gates were only of temporary construction, and owing to their gradual deterioration by the end of 1953 the water level in the marsh had risen and the salinity had increased so that *furens* again became a serious pest. Airplane spraying of the marshes with dieldrin and lindane at the rate of 1 pound and chlordane at 2 pounds per acre gave good control for several weeks, but was too expensive for any but emergency measures. Fog and mist sprays for adult control were almost useless, since the adults emerged in large numbers daily from the marsh during the breeding season. Painting window screens with DDT gave some protection inside houses, but some insects would pass the barrier and bite before the insecticide took effect.

METHODS OF COLLECTION AND STUDY

The primary source of our specimens has been the material obtained by the junior author from surveys for insects of medical importance at military installations in the Republic of Panama and the Canal Zone (Blanton, Galindo, and Peyton, 1955). These surveys were begun in the Canal Zone, but were gradually expanded to take in as large an area of the Republic of Panama as possible. Most of the surveys were made on the principal road systems of the Republic, but several were made at installations in Darién Province, accessible by boats of the Inter-American Geodetic Survey at Patino Point. A large series of collections was made at Almirante in Bocas del Toro Province in connection with the yellow fever studies carried on by the Gorgas Memorial Laboratory.

Nearly all our material was obtained by means of New Jersey light traps operated primarily for studies on mosquito distribution. Light traps were operated in about 150 localities (see map in fig. 2 for the principal locations). In each locality it was customary to operate as many as three generators and six or more light traps within a radius that could be serviced by a survey crew of two to eleven men. A Shannon trap was also operated in some areas. This trap is a tentlike enclosure made of cheesecloth or mosquito netting, hung from the four upper corners by tying cord or rope to limbs or trees at a height which

allows approximately 2 feet of clearance at the bottom of the tent. A light is hung inside near the top of the tent, and the insects that enter at the bottom are captured from the sides with an aspirator or killing bottle.

For a 2-year period beginning August 1951 the following collections were made in 517 nights of trap operation:

Insect	Numbers of individuals collected in—		
	1951 (5 mo.)	1952	1953 (8 mo.)
<i>Culicoides</i>	105, 586	235, 555	84, 000
Mosquitoes	73, 615	70, 867	96, 091
<i>Phlebotomus</i>	6, 114	31, 417	1, 492

Of the 150 localities where traps were operated, only the following received concentrated attention with more than 10 nights of operation, the remainder having been visited only from 1 to 10 nights each:

Locality	Nights	Months
Almirante	58	6
Garachiné	12	1
Jaqué	11	2
La Jolla	16	10
Loma Boracho	22	12
Mojinga Swamp	76	12
Patino Point	74	4
Tocumen	26	9

In spite of this coverage most of Panama has been very inadequately surveyed. The only possible exception is the Mojinga Swamp, where the trapping was done constantly over the entire period. At Almirante most of the trapping was done at one yellow fever tree station in a deep tropical rain forest, and many other habitats were not sampled. For unavoidable technical reasons the Darién trap locations were unsatisfactory for sampling *Culicoides* populations. Far too few collections were made from the subtropical mountain locations at Cerro Campana in Panamá Province and El Valle in Coclé Province, where nevertheless many unique records were obtained. The transect up the slope of the Volcán in Chiriquí Province was far too scanty to obtain more than a barest indication of that interesting temperate fauna. We have been able to secure only species that will come to light or horse-baited traps. From studies in North America we suspect that up to 10 or 20 percent of the fauna would never be taken in light traps and even fewer at animal bait. Thus at least a dozen additional species could very likely have been taken by a program of collection and rearing from larval habitats, had that been possible.

The light traps were equipped daily with jars containing fresh potassium cyanide, and the catches were placed each morning in pasteboard pill boxes and brought into the laboratory. A layer of

melted paradichlorobenzene had been poured in the bottoms of the pill boxes to afford protection against molds and museum pests, and the insects were placed in thin layers between padded filter cotton. The boxed specimens were stored in heated cabinets until the insects could be sorted. The insects of medical importance were determined in the laboratory or sent to specialists, and the residue of insects or trash was packed and labeled and sent to the U. S. National Museum in Washington, where many new and valuable insects were recovered and added to the National Collection.

For mounting on microscope slides, dry specimens were placed overnight in a warm saturated solution of phenol in absolute alcohol. By the next day the specimens were well cleared and were then transferred to a solution containing equal parts of Canada balsam and the liquefied phenol. After a few minutes they could be transferred to slides for dissection. Dissection consisted in cutting off the wings and mounting them in a separate drop of the mixture on one end of the slide under a separate cover glass, cutting off the head and orienting it anterior side up, and cutting off the abdomen and orienting it ventral side up. It was necessary to cut off the male genitalia between the eighth and ninth segments in order always to orient the specimen ventral side up. A small piece of broken cover glass was added to prevent undue flattening and the cover glass applied. After labeling, the slides were placed in a warm drying oven for about two weeks, and extra balsam was added from time to time to replace the mixture lost by evaporation of the phenol.

The types of the new species and most of the material studied are deposited in the U. S. National Museum. Paratypes and determined series of as many of the Panama species as available will be deposited in the following collections: British Museum (Natural History), London, England; Gorgas Memorial Laboratory, Ancón, Canal Zone; Instituto Nacional de Higiene, Caracas, Venezuela; Instituto Oswaldo Cruz, Rio de Janeiro, Brazil; Musée Royal d'Histoire Naturelle, Brussels, Belgium; Universidade de São Paulo, São Paulo, Brazil; and the University of Puerto Rico, San Juan, Puerto Rico.

In the distribution records, the first country given is that of the type locality and the remaining countries are listed alphabetically. The Panama localities are listed alphabetically by province; these localities are given according to the Esso Standard Oil highway map of Panama and the American Geographical Society's "Map of Hispanic America, 1:1,000,000." Some new distribution records for certain countries are given, based on specimens in the U. S. National Museum collection; for these the names of the towns or other data are added in parentheses. Unless otherwise indicated, all Panama records are based on specimens collected by the junior author in light traps. The

new Honduras and Nicaragua records are based on material collected in light traps operated in the yellow fever surveys by the Gorgas Memorial Laboratory under the direction of Pedro Galindo.

Our measurements are made with an ocular micrometer and, with rare exceptions, are of specimens cleared in phenol and mounted on slides in balsam. Measurements are usually made of a series of about 10 specimens and are presented in the descriptions according to the following system: "mean (minimum-maximum, n=number of measurements)." Measurements not given in that manner are of single specimens.

MORPHOLOGY

FIGURES 2, 3

The descriptions and figures of the structure of *Culicoides* given by Carter, Ingram, and Macfie (1920) are still classical, although valuable studies on the head structure have since been made by Jobling (1928) and Gad (1951), and on general anatomy by Tokunaga (1937) and Lee (1948). The following account is a revision of the generalized description of characters of the Heleidae given by Wirth (1952a).

HEAD: The head is subspherical, with the anterior surface more or less flattened and in line with the anterior surface of the proboscis. The dorsal surface of the head consists of the broad posterior occiput

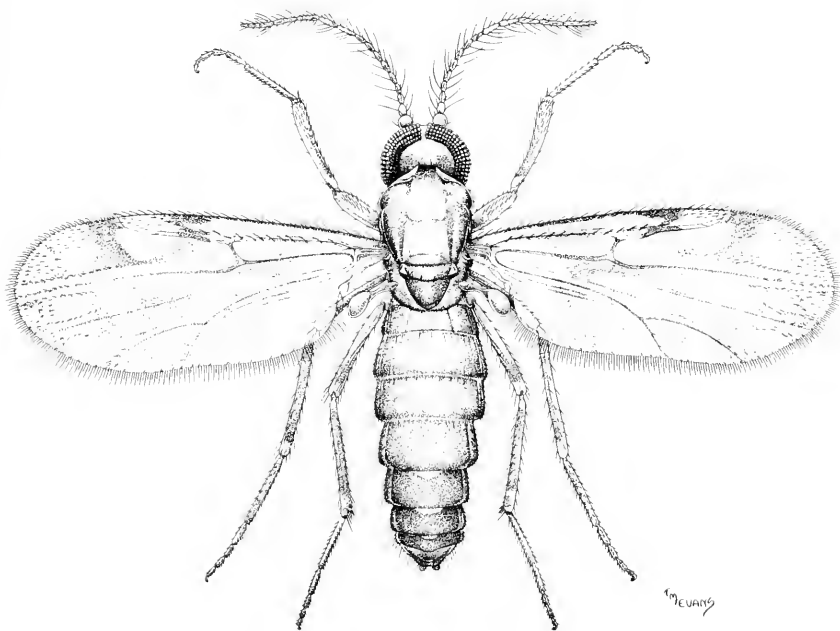


FIGURE 2.—*Culicoides diabolicus* Hoffman, dorsal aspect of female.

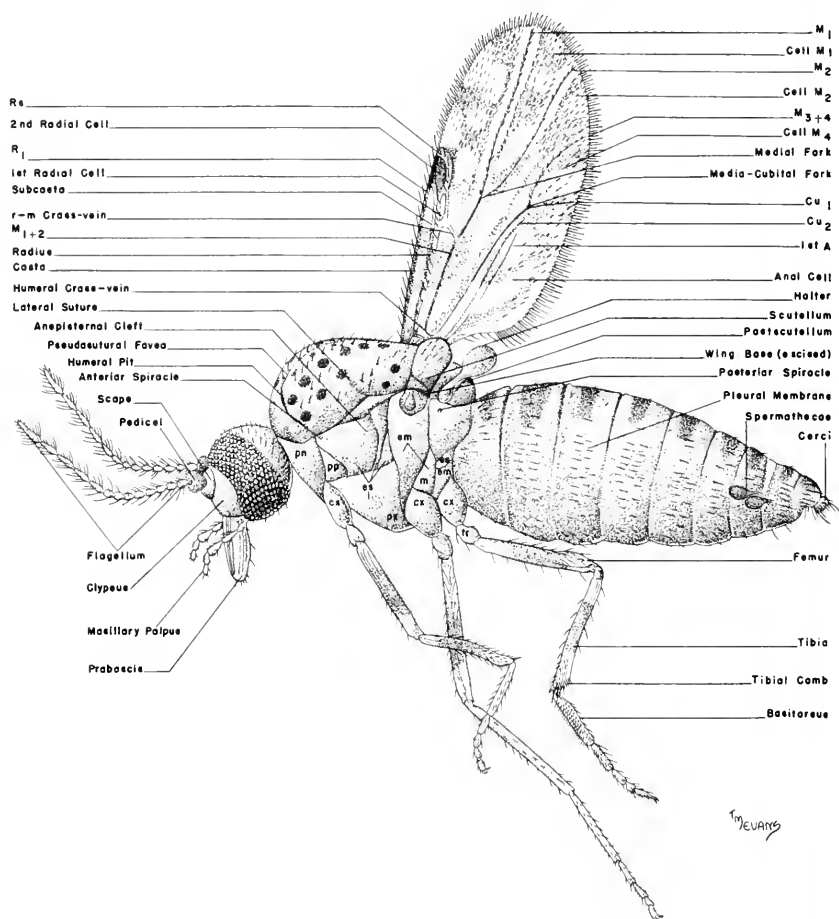


FIGURE 3.—*Culicoides furens* (Poey), lateral view of female, left wing and right legs removed, with parts labeled (cx, coxa; em, epimeron; m, meron; pn, pronotum; pp, propleuron; px, precoxale; tr, trochanter).

and an undifferentiated anterior vertex, usually with scattered setae and a row of orbital hairs bent over the eyes. The compound eyes are large and kidney-shaped and more or less contiguous above the bases of the antennae; they may be bare or with short pubescence between the ommatidial facets. The ocelli are undifferentiated. Between and below the compound eyes, the frontoclypeus surrounds the bases of the antennae in the frontal region above, and forms a convexly swollen clypeal region below at the base of the proboscis.

The antennae are divided into 15 units, which for convenience will be called segments in the traditional usage. The basal segment, or scape, is ringlike and hidden by the greatly enlarged pedicel. Seg-

ments 3 to 15 form the flagellum, which in the female is divided into three portions—an elongated third segment, the subequally shortened segments 4 to 10, and the elongated segments 11 to 15. All the flagellar segments bear scattered small hairs, and in addition each of the proximal eight bears a whorl of long hairs, or verticils. In the male, the pedicel is much more enlarged and the transition in the flagellar series occurs between segments 12 and 13, with segments 3 to 12 each bearing a whorl of very greatly elongated, erectile verticils forming a more or less dense plume. The presence of one to several minute hyaline sensory discs ringed by dense tufts of very short setae at the apices of certain flagellar segments is a character recently found to be extremely useful in the recognition of species or of species groups. The relative lengths of the segments are also useful in classification, and the antennal ratio, obtained by dividing the combined lengths of the last five segments by the combined lengths of the preceding eight, is a convenient way of expressing the most basic relation.

The mouthparts are well developed, stronger in the female than in the male, and in most species those of the female are especially fitted for piercing and blood-sucking. They are enclosed in an elongated proboscis often as long as the head capsule itself. Internally the sucking apparatus consists of a cibarial and a pharyngeal pump; no characters of the sclerotized parts of the pharyngeal apparatus have yet been found to have taxonomic value such as those described as the "buccopharyngeal apparatus" in other nematoceros families. The labium of the female is fleshy, with scattered hairs, enclosing the six other parts, which are slender, distally toothed, sclerotized blades of subequal lengths. These parts consist of a strong, distally toothed labrum, a pair of distally toothed mandibles, a pair of maxillae represented by the bladelike laciniae, and a tubular hypopharynx also bearing distal teeth. The number of teeth on the mandible has been found to be especially useful in differentiation of closely related species. The maxillary palpus is 5-segmented and the third segment is more or less swollen and bears on the mesal surface a specialized sense organ, the nature of which is a very valuable specific character. The mouthparts of the male are similar to those of the female, but much more poorly developed, without distal teeth, and not fitted for piercing.

THORAX: The thorax is moderately broad and very convex above, arched anteriorly, and projecting very slightly over the head. The pronotum is divided into lateral halves by the anterior development of the mesonotum and lies partly hidden just below the humeri. The mesonotum bears in this and in a few related genera a pair of small sensory pits sublaterally on the humeral corners near the

anterior margin, with a pair of almost invisible, slightly depressed lines, the pseudosutural foveae, extending from the pits caudad to near the sides of the scutellum. The mesonotum is clothed with short hairs, which may be somewhat enlarged in rows along the foveae. When a color pattern or pattern of pruinose markings is present, the sublateral markings usually have their mesal margins at the foveae and their greatest breadth is usually at lateral extensions toward the mesonotal or lateral suture, which extends midway on each side from the lateral margins of the mesonotum a short distance mesad. The prescutellar area of the mesonotum is more or less flattened and bears a submedian pair of sensory areas. The scutellum is transverse, with a median caudal expansion and bears a number of strong bristles and short hairs. The postscutellum is arched and bare, with a small, deep, glandular depression. The pleura are bare, each divided into a number of sclerites, with a broad membranous cleft on the anepisternum of the mesopleuron, with an anterior spiracle located in the membrane just behind the pronotum and the posterior spiracle located on the metapleural membrane just below the halter.

The legs are moderately slender, the femora sometimes slightly swollen, not bearing modified spines or scales. At the apex of the fore tibia are a small spur and a tuft of modified hairs, and at the apex of the hind tibia are an anterior spur and two transverse rows of modified spinose hairs. The term "hind tibial comb" includes only the long spines in the distal row and is sometimes useful in classification. The tarsal ratio is the length of the hind basitarsus divided by the length of the second tarsomere, but we have not found it to be of much taxonomic value in this genus. The fourth tarsomere on all legs is usually cylindrical, but in the subgenus *Macfella* Fox it is cordiform. The claws are small and equal on all legs, simple in the female and divided at the apices in the male; the empodium is vestigial.

The wings possess dense microtrichia, and the macrotrichia or long hairs may range from numerous to absent. There is usually a pattern of pale and dark spots or bands, which is of prime importance in classification. The costa extends from the base of the wing to half or more than three-fourths of the wing length. There are with rare exceptions two complete radial cells formed by the heavily sclerotized radial branches. The radial cells are usually of subequal lengths, and the second or distal one is usually broader than the first, which may frequently be slitlike. We use the Tillyard modification of the Comstock-Needham system of wing venation, whereby the branches of the anterior fork are called M_1 and M_2 and those of the posterior fork M_{3+4} and Cu_1 , from front to back. We

employ an exact measurement of the wing length, comprising the distance from the basal arculus to the tip of the wing, which is about a tenth less than the measurement to the basal attachment of the wing commonly employed by other authors. The color of the halter is frequently of taxonomic importance.

ABDOMEN: The female abdomen is relatively stout, the apex somewhat tapered, with a pair of small, rounded cerci visible below the ninth tergum. Internally the female usually possesses sclerotized spermathecae which are usually spherical to pyriform, sometimes with the bases of the ducts sclerotized a short distance. The number of completely formed, sclerotized spermathecae varies from none to three; all the known Panama species have one or two. The spermathecae are joined by nonsclerotized ducts to a common duct, and at the juncture there is sometimes a small sclerotized ring. In some species with two functional spermathecae the small rudimentary third one is also sclerotized. In our descriptions we make no mention of this third rudimentary spermathecae and ring. We measure the length of the spermatheca in the axis of the base of the duct and include the sclerotized portion of the duct.

The male abdomen is very slender and bears terminally the prominent genitalia, which are of primary importance in group classification and species identification. The ninth segment is in the form of an irregular sclerotized ring consisting of the fused tergum and sternum. The ninth tergum is in the form of an expanded lobe or plate, convex externally and hollowed out mesad and bearing the anus flanked by a pair of membranous setose anal lobes or cerci on the ventromesal face. The hind corners of the ninth tergum are frequently expanded as a pair of apicolateral processes. The ninth sternum is much shorter than the tergum, usually with a caudomedian excavation on its hind margin, at the lateral corners of which the base of the aedeagus articulates. The forceps-like genital appendages, or gonopods, arise laterally at the base of the tergum and are 2-segmented. The enlarged basal segment (basistyle or side piece) bears two internal processes at the base, a mesally directed ventral root and an anteriorly directed dorsal root, the latter articulating directly with the base of the paramere. The distal segment (dististyle or clasper) is hairy and slightly swollen at the base, slender and nearly bare distally, with an incurved point, and when not extended is folded mesad from the apex of the basistyle across the mesal face of the ninth tergum. The aedeagus is usually a Y-shaped structure with the stem directed ventrocaudad, forming the sclerotized support on the ventral surface of the male genital duct. The distal portion of the aedeagus is less sclerotized than the basal arms or arch, is usually shallowly U-shaped in cross section and may be variously ornamented or modified distally

and laterally. The basal arch of the aedeagus is connected to the posterior excavation of the ninth sternum by a hyaline membrane which in a few species is partially covered with spinules or spicules. The parameres are usually a pair of sclerotized internal rodlike sclerites with knobbed bases and ventrally directed distal points, but they are subject to great modifications in the shape and direction of the basal knob, the middle stem, or the distal point. In some groups of species the parameres may fuse mesad and become platelike.

Systematic Discussion

The modern classification of the genus *Culicoides* had its beginnings as recently as 1937, when Root and Hoffman grouped the North American species according to the characters of the male genitalia supported by a number of external characters. Edwards followed and enlarged upon this system in 1939 with a grouping of the Palaearctic species. In 1948 Fox erected the subgenus *Hoffmania* for a number of Neotropical species which he differentiated from *Culicoides*, s. str. Ortiz (1950) accepted and strengthened Fox's concept of the subgenus *Hoffmania*. Wirth (1952a) attempted only to follow Root and Hoffman's outline in assigning the California species to groups without respect to subgenera. None of the recent regional revisions—such as those by Causey (1938, Siam), Fiedler (1951, South Africa), Gutsevitch (1952, Russia), Lee and Reye (1953, Australia), and Foote and Pratt (1954, eastern United States)—attempt any grouping of species.

The first important attempt to bring the genus *Culicoides* into a phylogenetic system was by Khalaf (1954), who placed the species of the world in four subgenera—*Culicoides*, s. str., *Oecacta* Poey, *Selfa* Khalaf, and *Monoculicoides* Khalaf—assigning all the species whose genitalic characters had been figured in the literature to five complexes and 21 groups within these subgenera. Although Khalaf's concept of important phylogenetic characters was basically sound, he was hindered by the limited information available in the literature. In a genus whose taxonomy is expanding so rapidly we may expect numerous reshufflings of groups as new species are described and our knowledge of the older species improves. Vargas' (1953a) proposal of the subgenus *Beltranmyia* for species of the *crepuscularis* group and Fox's (1955a) erection of the subgenera *Avaritia* for the *obsoletus* group and *Macfiella* for the *phlebotomus* group furnish badly needed subgeneric names, but numerous species will probably pass through various taxa before being assigned to their correct phylogenetic niches.

We believe that in a genus as large and compact as *Culicoides* the number of subgenera will eventually have to be increased fourfold

or fivefold, but until a considerable portion of the species from each region are well described and a general fund of taxonomic characters is made available to work with, no system of classification should be attempted which would be more than a convenient way to think flexibly in terms of groups of related species. We believe that the literature and generic synonymies will be more easily handled in later years if our first attempts to group the species phylogenetically are done in terms of taxa outside the rules of priority and nomenclatural bookkeeping. As certain groups become comparatively well known and the relations of the species are worked out on a natural basis, the groupings can be formalized with subgeneric names. For these reasons we are proposing a tentative framework of taxonomic groups of the Panama species, utilizing subgeneric names for some when these are already available and appropriate, but refraining from proposing any new subgenera at this time.

Our proposed classification of the Panama species (table 4) serves as a systematic check list of species and a convenient summary of the most important quantitative characters used. The species numbers in this table agree with the species numbers in the crossheads throughout the text. An alphabetical list of species and synonyms is presented on page 474.

TABLE 4.—*Systematic arrangement of Panama species of Culicoides with certain quantitative characters*

(NOTE: Except for segments having sensoria, mean values are shown. Asterisk denotes doubtful position of species in group. Parentheses enclosing segment numbers indicate these segments sometimes have sensoria)

Subgenera, groups, and species	Wing length (mm.)	Costal ratio	Antennal ratio	Segments having sensoria	No. mandibular teeth	No. tibial spines
Culicoides (Hoffmania)						
The hylas group						
1. heliconiae	1. 46	0. 68	1. 06	3, 11-15	23	6
2. hylas	1. 19	0. 68	1. 12	3, 11-15	19	6
3. verecundus	1. 31	0. 70	1. 10	3, 11-15	23	6
The guttatus group						
4. diabolicus	1. 03	0. 67	1. 14	3, 11-15	15	5
5. foxi	1. 21	0. 68	1. 10	3, 11-15	16	6
6. insignis	1. 11	0. 65	1. 32	3, 5, 7, 9, 11-15.	21	6
7. trinidadensis	1. 12	0. 66	1. 22	3, 5, 7, 9, 11-15.	17	5
Culicoides (Avaritia)						
8. pusilloides	0. 69	0. 57	1. 12	3, 12-15	13	5
9. pusillus	0. 64	0. 53	1. 18	3, 13-15	14	5

TABLE 4.—*Systematic arrangement of Panama species of Culicoides with certain quantitative characters*—Continued

(NOTE: Except for segments having sensoria, mean values are shown. Asterisk denotes doubtful position of species in group. Parentheses enclosing segment numbers indicate these segments sometimes have sensoria)

Subgenera, groups, and species	Wing length (mm.)	Costal ratio	Antennal ratio	Segments having sensoria	No. mandibular teeth	No. tibial spines
<i>Culicoides</i> (<i>Culicoides</i>)						
The pulicaris group						
10. elutus	1. 14	0. 65	0. 93	3, 11-15	16	6
11. luteovenus	1. 35	0. 60	0. 99	3, 11-15	14	6
The covagarciai group						
12. efferus	1. 49	0. 67	0. 93	3, 11-15	24	6
13. rostratus	1. 13	0. 68	0. 98	3, 11-15	20	6
14. marshi	1. 18	0. 68	1. 18	3, 11-15	27	5
15. covagarciai	1. 19	0. 67	1. 09	3, 11-15	15	6
16. metagonatus	1. 02	0. 63	0. 95	3, 11-15	15	6
The nigrigenus group						
17. nigrigenus	1. 11	0. 64	2. 00	3-15	13	4
18. lutealaris	1. 56	0. 58	1. 30	3-15	14	4
19. chrysonotus	1. 66	0. 60	2. 10	3, 8-15	14	4
<i>Culicoides</i> (<i>Oecacta</i>)						
The daedalus group						
20. antefurcatus	0. 79	0. 58	1. 16	3, 11-15	14	4
21. crescentis	0. 95	0. 62	1. 48	3, 11-15	13	4
22. daedalus	1. 01	0. 62	1. 34	3, 11-15	13	4
23. commatis	1. 02	0. 58	1. 19	3, 5, 7, 9, 11-15.	12	4
24. pampoikilus	1. 25	0. 59	1. 39	3, 5, 7, 9, 11-15.	14	4
25. phaeonotus	1. 06	0. 61	1. 63	3, 5, 7, 9, 11-15.	12	4
26. dunni	1. 12	0. 56	1. 13	3, 4, 6, 7, 9, 11-15.	18	4
27. daedaloides*	1. 0	0. 63	1. 48	3, 8-10	12	4
The copiosus group						
28. pilosus	0. 99	0. 59	1. 56	3-9, 11-15	17	4
29. panamensis	0. 87	0. 55	1. 12	3, 11-15	10	4
30. poikilonotus	0. 83	0. 61	1. 26	3, 11-15	10	4
31. jamaicensis	0. 97	0. 57	1. 21	3-15	15	4
The iriartei group						
32. evansi	1. 17	0. 57	1. 02	3, 7-10	13	4
33. iriartei	0. 93	0. 61	1. 42	3, 7-10	11	4
The scopus group						
34. scopus	1. 34	0. 58	1. 65	3, 8, 10-15	15	4
The limai group						
35. galindoi	0. 83	0. 62	0. 95	3, 7-10	14	4
36. limai	0. 80	0. 63	1. 06	3, 7-10	13	4
37. tenuilobus	0. 89	0. 62	1. 13	3, 7-10	13	4
38. camposi	0. 86	0. 59	1. 18	3, 7-10	13-14	4

TABLE 4.—*Systematic arrangement of Panama species of Culicoides with certain quantitative characters*—Continued

(NOTE: Except for segments having sensoria, mean values are shown. Asterisk denotes doubtful position of species in group. Parentheses enclosing segment numbers indicate these segments sometimes have sensoria)

Subgenera, groups, and species	Wing length (mm.)	Costal ratio	Antennal ratio	Segments having sensoria	No. mandibular teeth	No. tibial spines
Culicoides (Oecacta)—Con						
The limai group—Con.						
39. carpenteri*	0.99	0.61	1.22	3, 11-14	14	4
40. magnipalpis*	1.07	0.60	0.91	3, 11-15	13	4
The acotylus group						
41. wokei	0.78	0.61	0.95	3-10	14	4
42. carsiomelas	0.99	0.65	0.96	3, 7-10	13	4
43. acotylus	1.05	0.70	0.78	3, 6(7)-10	15	5
44. guyanensis	0.99	0.58	1.00	3, 6-10	15	4
45. venezuelensis	1.37	0.58	1.19	3, (5-10) 11-14.	13	5
46. lanei	1.02	0.66	0.72	3, 7-10	13	4
The reticulatus group						
47. azureus	1.04	0.63	1.18	3, 7-10	14-15	4
48. mojingaensis	0.96	0.66	1.32	3, (7)8-10	14	4
49. paucienfuscatus	1.02	0.63	1.18	3, 7-10	12	4
50. pifanoi	0.79	0.60	0.91	3, 7-10	14	4
51. dicrourus	1.14	0.65	1.04	3, 6-10	13	4
52. volcanensis	1.45	0.61	1.07	3, 7-10	13	4
53. lyrinotatus	1.17	0.68	1.01	3, 8-10	12	4
54. reticulatus	0.96	0.65	1.10	3, 8-10	21	4
55. macrostigma*	0.91	0.71	1.97	3, 8-10	11	4
The furens group						
56. alahialinus	0.96	0.64	1.01	3, 8-10	15	4
57. barbosai	0.88	0.58	0.93	3, 7-10	16	4
58. gorgasi	1.04	0.64	0.99	3, 7(8)-10	17	4
59. furens	0.91	0.58	1.28	3, 7-10	15	4
The fluvialis group						
60. fluvialis	0.78	0.61	1.07	3, 8-10	13	4
61. tetrathyris	0.85	0.70	1.09	3, 8-10	14	4
62. propriipennis	0.85	0.63	0.97	3, 8-14	15	4
63. balsapambensis	0.72	0.70	0.84	3, 8-10	14	4
64. castillae	0.84	0.64	1.09	3, 8-11	15	4
65. leopoldoi	0.85	0.61	1.21	3, 7-10	13	4
The transferrans group						
66. patulipalpis	0.98	0.64	1.85	3, 10-14	14	4
67. rangeli	1.01	0.65	1.63	3, 10-14	16	4
68. transferrans	0.98	0.64	1.43	3, 11-14	15	4
The leoni group						
69. fieldi	0.72	0.60	0.85	3, 8-10	12	4
70. glabellus	0.68	0.56	0.88	3, 8-10	12	4

TABLE 4.—*Systematic arrangement of Panama species of Culicoides with certain quantitative characters*—Continued

(NOTE: Except for segments having sensoria, mean values are shown. Asterisk denotes doubtful position of species in group. Parentheses enclosing segment numbers indicate these segments sometimes have sensoria)

Subgenera, groups, and species	Wing length (mm.)	Costal ratio	Antennal ratio	Segments having sensoria	No. mandibular teeth	No. tibial spines
Culicoides (Oecacta)—Con.						
The debilipalpis group						
71. gabaldoni	0. 65	0. 62	0. 91	3, 8-10	11	4
72. spurius	0. 72	0. 58	0. 84	3, 8-10	13	4
73. hoffmani	0. 76	0. 59	0. 79	3, 8-10	14	4
74. imitator	0. 68	0. 53	0. 91	3, 8-10	13	4
75. paraensis	0. 78	0. 59	0. 77	3, 8-10	15	4
76. debilipalpis	0. 80	0. 65	0. 83	3, 8-10	15	4
77. mirsae	0. 78	0. 61	0. 70	3, 8-10	16	4
78. aureus	0. 89	0. 63	0. 76	3, 7-10	18	4
79. ginesi	0. 80	0. 62	0. 74	3, 7-10	17	4
80. glabrior	1. 02	0. 68	0. 89	3, 7-10	15	4
The pachymerus group						
81. almirantei	0. 79	0. 69	1. 25	3, 8-10	15	4
82. caprilesi	0. 83	0. 78	0. 61	3, 8-10	16-17	4
83. pachymerus	0. 72	0. 71	0. 66	3, 8(9)-10	14	4
84. uniradialis	0. 94	0. 79	0. 65	3, 8-10	16	4
The arubae group						
85. arubae	1. 17	0. 52	0. 87	3-10	15	7
The stigmalis group						
86. stigmalis	0. 90	0. 64	0. 91	3, 8-10	14	4
Culicoides (Macfiella)						
87. phlebotomus	1. 03	0. 55	1. 19	3, 6-10	15	7
88. willistoni	0. 92	0. 55	1. 06	3-10	14	6

Key to the Panama Species of *Culicoides*

(Primarily for Females)

1. Second radial cell wholly or mainly included in a light spot 2
 Second radial cell wholly included in a very dark spot 22
2. Base of cell M_4 pale bordering veins M_{3+4} and Cu_1 or apices of veins M_1 and M_2 pale 3
 Base of cell M_4 and adjacent veins in a dark area; apices of veins M_1 and M_2 not pale 9
3. Cell R_5 with a separate pale spot present anterior to base of vein M_1 4
 Cell R_5 without a separate pale spot present anterior to base of vein M_1 , pale area continuous from r-m crossvein to borders of vein M_1 6

4. Hind femur dark to apex; apices of veins M_{3+4} and Cu_1 usually pale . 5
Hind femur with subapical yellow band; apices of veins M_{3+4} and Cu_1
dark; third palpal segment slender, without pit; mesonotum yellow
in middle with dark brown sublateral vittae; wing 1.3 mm. long.
verecundus Macfie (p. 278)
5. Midknee broadly yellow at the joint; mesonotum dark gray in middle,
nearly unicolorous blackish; third palpal segment slender, without
pit; wing 1.5 mm. long *heliconiae* Fox and Hoffman (p. 274)
Midknee black with narrow pale rings on each side; mesonotum yellow
in middle with dark brown sublateral vittae; third palpal segment
swollen with a shallow, subdivided pit; wing 1.2 mm. long.
hylas Macfie (p. 276)
- 6 (3). Cell M_1 with two pale spots distal to the double spot straddling vein
 M_2 ; palpal pit with regular margins present; halter knob pale or
dark 7
Cell M_1 with only one pale spot distal to the double spot straddling
vein M_2 ; palpal pit irregular or absent; halter knob brown 8
7. Small black spot present on vein R_{4+5} near end of second radial cell;
halter knob dark; larger species (wing 1.2 mm. long). *foxi* Ortiz (p. 283)
No small black spot on vein R_{4+5} near end of second radial cell; halter
knob usually pale; smaller species (wing 1.0 mm. long).
diabolicus Hoffman (p. 280)
- 8 (6). Vein R_{4+5} blackened into adjacent distal pale area up to a point where
vein turns abruptly forward to meet the costa; mesonotum with
prominent pattern; third palpal segment with definite, irregular
sensory pit *insignis* Lutz (p. 285)
Vein R_{4+5} not blackened into adjacent distal pale area; mesonotum
uniformly grayish brown pruinose; third palpal segment without
sensory pit *trinidadensis* Hoffman (p. 287)
- 9 (2). Very small species, wing 0.64–0.69 mm. long; costa short, extending
only 0.53–0.57 of distance to wing tip; second radial cell short;
mesonotum bluish black with faint sublateral black vittae 10
Larger species, wing 0.72–1.66 mm. long; costa longer, reaching 0.58–0.79
of distance to wing tip; second radial cell usually long; mesonotum
yellowish to brown (or if blackish there are gray patches present and
the legs are dark) 11
10. Second radial cell pale only on extreme distal end; wing pattern very
faint; legs pale except for dark knee spots; pit of third palpal segment
faint or absent; spermathecae oval and subequal.
pusillus Lutz (part) (p. 292)
Second radial cell on distal half; wing pattern prominent; legs brown
with pale bands; palpal pit deep; spermathecae subspherical and very
unequal *pusilloides* Wirth and Blanton (p. 290)
- 11 (9). Legs stout, fore and hind femora greatly swollen, subapical pale rings
present on all femora; mesonotum dull, tawny, yellowish brown;
distal sensory tufts absent on antennal segments XI–XV 12
Legs slender, femora slender, yellow with dark knees or dark with pale
knees, never with subapical pale rings; mesonotum if yellow then
subshining; distal sensory tufts present on antennal segments XI–
XV 13

12. Only one radial cell present; wing 0.94 mm. long; costa long, extending to 0.79 of wing length; wing entirely without macrotrichia.
uniradialis Wirth and Blanton (p. 462)
 Two radial cells present; wing 0.72 mm. long; costa extending to 0.71 of wing length; wing with a few macrotrichia on distal fourth.
pachymerus Lutz (p. 459)
- 13 (11). Legs black, at most with small pale spots; mesonotum blackish, entirely dull gray pruinose or dark brown with gray pruinose pattern . . . 14
 Legs yellow or with knees broadly yellow-banded; mesonotum yellow to brown, usually subshining . . . 15
14. Mesonotum with pattern of interconnected, subshining, dark brown patches . . . *lutcovenus* Root and Hoffman (p. 297)
 Mesonotum uniformly dark pruinose brown, without pattern.
elutus Macfie (p. 295)
- 15 (13). Proboscis longer than height of head; legs pale including knees; wing pale with effect of narrow, irregular, transverse bands . . . 16
 Proboscis shorter than height of head; legs pale with black knee spots or brown with knees broadly pale; third palpal segment more or less swollen. . . 18
16. Legs brown with knees and apex of hind tibia broadly yellow; third palpal segment long and slender with a small pit; mandible with 27 teeth . . . *marshi* Wirth and Blanton (p. 302)
 Legs pale including knees; mandible with 20-24 teeth . . . 17
17. Third palpal segment long and slender with small pit.
efferus Fox (p. 299)
 Third palpal segment swollen with open sensory area.
rostratus Wirth and Blanton (p. 301)
- 18 (15). Knees pale; legs brownish with broad pale bands including knees on apices of fore and mid femora, bases of all tibia and apex of hind tibia . . . *covagarciai* Ortiz (p. 304)
 Knees with a black spot, at least on hind pair; legs otherwise, mostly yellowish . . . 19
19. All knees with black spots; femora more or less brownish with subapical pale bands; third palpal segment with small sensory pit; basal antennal segments moniliform, the 11th segment 2-3 times as long as tenth . . . 20
 Legs yellow, only hind knee with black spots; third palpal segment without sensory pit; 11th antennal segment not markedly longer than 10th . . . *metagonatus* Wirth and Blanton (p. 306)
20. Distal pale spot in cell M_1 not attaining wing margin; pale spot straddling vein M_1 separate from the pale spot in cell R_5 at end of second radial cell; pale spot straddling vein M_2 in form of a double, more or less quadrate spot; femora blackish from near base to past middle; third palpal segment slightly swollen; wing 1.66 mm. long.
chrysonotus Wirth and Blanton (p. 312)
 Distal pale spot in cell M_1 continuous anteriorly with the pale spot in cell R_5 at the end of second radial cell; third palpal segment greatly swollen . . . 21
21. All femora dark brown from near base to past middle; tibiae brownish with narrow subbasal pale band; wing 1.56 mm. long.
lutealaris Wirth and Blanton (p. 310)

Fore and mid femora pale brown on basal portions, hind femur with a broad median darker brown band; wing 1.11 mm. long.

nigrigenus Wirth and Blanton (p. 308)

- 22 (1). Pale spots at periphery of wing very faint 23
 Pale spots at periphery of wing well defined; macrotrichia of wing more or less abundant 25
23. Wing practically bare of macrotrichia; stigmal spot blackish; mesonotum blackish 24
 Wing with sparse but widely distributed macrotrichia; stigmal spot scarcely darker than rest of wing; mesonotum pale brown with faint pattern of punctiform brown dots . . . **alahialinus** Barbosa (p. 398)
24. Small species, wing 0.65 mm. long; second radial cell short, costa ending at 0.53 of distance to wing tip; halter yellowish; legs yellow except for dark knee spots; mesonotum with bluish pruinosity and a sublateral pair of narrow blackish bands.
pusillus Lutz (part) (p. 292)
 Large species, wing 0.90 mm. long; second radial cell long, costa extending to 0.64 of distance to wing tip; halter dark; legs dark, faint pale bands at base of hind tibia; mesonotum uniformly dull, dark brown **stigmalis** Wirth (p. 467)
- 25 (22). Wing with a pale spot straddling middle of vein M_2 , or veins M_1 and M_2 entirely pale-margined, including this area 26
 Wing with no pale spot straddling vein M_2 , this vein usually dark to apex 54
26. Wing with pale markings extensive, interconnected 27
 Wing dark with well-separated pale spots 32
27. Halter knob pale; mesonotum with prominent pattern of large patches or lines; anterior margin of wing with one very dark spot over second radial cell; cell R_5 with two pale areas between end of costa and wing tip 28
 Halter knob dark; mesonotum with a pattern of punctiform dots; anterior margin of wing with three very dark spots, cell R_5 with three pale areas between end of costa and wing tip.
arubae Fox and Hoffman (p. 464)
28. Cell M_1 with distal spot not or very narrowly reaching wing margin 29
 Cell M_1 with distal pale spot broadly reaching wing margin; mesonotum yellowish with dark brown sublateral bands 30
29. Cell M_1 with distal pale spot shorter than dark area between it and wing margin; cell R_5 with poststigmatic pale spot not enclosing a dark spot behind second radial cell; mesonotum yellowish with dark brown sublateral bands **pifanoi** Ortiz (p. 384)
 Cell M_1 with distal pale spot longer than dark area between it and wing margin; poststigmatic pale spot in cell R_5 U-shaped, enclosing a small dark spot behind second radial cell; mesonotum grayish pruinose with three narrow dark longitudinal lines.
paucienfuscatus Barbosa (p. 381)
- 30 (28). Hind femur and tibia dark on apices.
galindoi Wirth and Blanton (part) (p. 349)
 Hind femur with subapical pale ring; hind tibia with apex broadly pale 31

31. Slender species, discal area of wing mostly pale; pale area definitely straddling base of vein M_2 ; abdomen whitish on basal half above; antenna with sensoria present on segments III, XI-XIV.
carpenteri Wirth and Blanton (p. 358)
- Stockier species, discal area of wing with dark markings at least as extensive as the pale ones, pale mark in base of cell M_1 rarely straddling vein M_2 ; abdomen blackish; antenna with sensoria present on segments III, VII-X **limai** Barretto (part) (p. 352)
- 32 (26). Vein M_1 with pale spot present straddling basal or middle portion . . . 33
 Vein M_1 without pale spot straddling basal or middle portion . . . 37
33. Crossvein r-m with dark spot in center of pale area; mesonotum uniformly pruinose brown . . . **scopus** Root and Hoffman (p. 347)
 Crossvein r-m pale; mesonotum with a prominent pattern . . . 34
34. Anal cell with two pale spots in distal portion 35
 Anal cell with one pale spot in distal portion; mesonotum brown with three darker longitudinal bands; apices of veins M_1 , M_2 and M_{3+4} dark **panamensis** Barbosa (part) (p. 334)
35. Pale spot straddling vein M_1 located near base of the vein; apices of veins M_1 , M_2 and M_{3+4} with pale spots; wing very hairy; mesonotum brown with three broad, darker, longitudinal bands narrowly bordered with whitish pruinosity; cell R_5 with distal pale spot divided or hourglass-shaped and broadly meeting wing margin.
jamaicensis Edwards (p. 339)
 Pale spot straddling vein M_1 located at midlength of vein; apices of veins M_1 , M_2 and M_{3+4} dark; mesonotum yellowish with brown markings; cell R_5 with distal pale spot round and not reaching wing margin 36
36. Mesonotum on anterior half brown with yellow patches, posteriorly yellow; cell R_5 with poststigmatic pale spot angulate, distal one small and round; wing nearly bare; legs with broad pale bands.
camposi Ortiz and Leon (p. 356)
 Mesonotum yellowish brown with brownish sublateral bands; cell R_5 with both pale spots quadrate, large; wing hairy to base, legs with narrow pale rings **dunni**, new species (part) (p. 328)
- 37 (32). Anal cell with a single pale spot in distal portion 38
 Anal cell with two pale spots, which may be partly coalesced, in distal portion 44
38. Cell R_5 with one or two small elongate pale spots present lying adjacent to vein M_1 on its basal or midportion 39
 Cell R_5 without pale spot lying adjacent to vein M_1 40
39. Cell R_5 with two pale spots lying adjacent to vein M_1 , one proximad and one distad of level of the posterior poststigmatic pale spot; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 with pale spots at wing margin, veins M_{3+4} and Cu_1 pale bordered in base of cell M_4 .
iriartei Fox (p. 344)
 Cell R_5 with one pale spot lying adjacent to vein M_1 , at level of anterior poststigmatic pale spot; apices of veins M_1 to Cu_1 dark; veins M_{3+4} and Cu_1 not pale bordered in base of cell M_4 .
panamensis Barbosa (part) (p. 334)
- 40 (38). Cell R_5 without pale spot lying between poststigmatic and distal pale spots; mesonotum with prominent pattern of brown lines or patches; fourth tarsomere cylindrical 41

- Cell R_5 with a small round distal pale spot lying between the poststigmatic pale spot and the distal pale spot; cell M_1 with distal pale spot located far from wing margin; mesonotum grayish green pollinose, without pattern or with small brown punctiform dots, fourth tarsomere cordiform 43
41. Cell R_5 with distal pale spot filling apex of cell; cell M_1 with distal pale spot broadly reaching wing margin.
tenuilobus new species (p. 354)
 Cell R_5 with distal pale spot transverse, located far from apex of cell; cell M_1 with distal pale spot lying far from wing margin 42
42. Mesonotum grayish pruinose with dark brown patches; anal cell with distal pale spot not double; hind femur dark at apex.
evansi, new species (p. 342)
 Mesonotum yellowish brown pruinose with H-shaped marking of brown lines; anal cell with distal pale spot double; hind femur with subapical pale ring **daedaloides**, new species (part) (p. 330)
- 43 (40). Mesonotum with pattern of prominent punctiform brown dots.
willistoni Wirth and Blanton (p. 471)
 Mesonotum uniformly grayish green pollinose, sometimes with a pair of faint, brownish, sublateral longitudinal lines.
phlebotomus (Williston) (p. 469)
- 44 (37). Cell M_1 with two pale spots past the pale spot straddling vein M_2 ; cell R_5 with six small round pale spots.
venezuelensis Ortiz and Mirsa (part) (p. 372)
 Cell M_1 with only one distal pale spot; cell R_5 with less than four pale spots 45
45. Cell R_5 with a small, elongate pale spot present lying adjacent to vein M_1 on its midportion 46
 Cell R_5 without pale spot lying adjacent to vein M_1 on its midportion 48
46. Apices of veins M_1 , M_2 and M_{3+4} with a pale spot at wing margin; cell R_5 with pale spot lying in front of vein M_1 located between poststigmatic and distal pale spots 47
 Apices of veins M_1 , M_2 and M_{3+4} dark; cell R_5 with pale spot lying in front of vein M_1 located at same level as poststigmatic pale spot.
dunni, new species (part) (p. 328)
47. Cell R_5 with distal pale spot crescent-shaped, concave on distal side; mesonotum with pattern of three broad, longitudinal bands and associated small brown dots; hind femur and tibia dark.
crescentis, new species (p. 317)
 Cell R_5 with distal pale spot transversely oval, not concave on distal side; mesonotum with pattern of narrow, reticulated brown lines; hind femur with subapical and hind tibia with apical pale rings.
poikilonotus Macfie (part) (p. 337)
- 48 (45). Cell M_1 with distal pale spot lying far from wing margin 49
 Cell M_1 with distal pale spot nearly or quite reaching wing margin 50
49. Anal cell with distal pale spots well separated and obliquely located; hind femur dark at apex; poststigmatic pale spots in cell R_5 fused; wing very hairy to base **daedalus** Macfie (p. 319)
 Anal cell with distal pale spots fused in a transverse double spot; hind femur with subapical pale ring; poststigmatic pale spots in cell R_5 separated; wing with sparse hairs on distal third.
daedaloides, new species (part) (p. 330)

50. Cell R_5 with distal pale spot comma-shaped, bearing a small distal extension from posterior side 51
 Cell R_5 with distal pale spot not appendiculate but quadrate to round or oval in shape 52
51. Cell R_5 with main body of distal pale spot small and transverse; veins M_{3+4} and Cu_1 pale margined in cell M_4 ; pale spot present in cell M_2 behind medial fork; larger (wing 1.25 mm. long).
pampoikilus Macfie (p. 324)
 Cell R_5 with main body of distal pale spot large and rounded; veins M_{3+4} and Cu_1 not pale margined in cell M_4 ; pale spot absent in cell M_2 behind medial fork; smaller (wing 1.02 mm. long).
commatis, new species (p. 321)
- 52 (50). Cell R_5 with distal pale spot filling cell to apex.
antefurcatus, new species (p. 315)
 Cell R_5 with distal pale spot rounded or quadrate, not extending to apex of cell. 53
53. Mesonotum yellowish brown with dark brown pattern; antenna with sensoria present on segments III to IX and XI to XV.
pilosus, new species (p. 332)
 Mesonotum dark brown with darker brown pattern; antenna with sensoria present on segments III, V, VII, IX and XI to XV.
phaeonotus, new species (p. 326)
- 54 (25). Cell M_1 with three pale spots 55
 Cell M_1 with two pale spots 60
55. Cell R_5 with three small pale spots arranged in a triangle with apex at end of costa and distad with a large, subapical, double spot; cell M_1 with small distal pale spot very small at wing margin and usually narrowly connected to large spot in middle of cell; mesonotum with pattern of small punctiform brown dots; branches of media pale-bordered **furens** (Poey) (p. 404)
 Cell R_5 with pale spots arranged differently. 56
56. Cell R_5 with three small, rounded pale spots arranged in a triangle in distal half of cell 57
 Cell R_5 with two pale spots in distal half. 58
57. Cell R_5 with three small round pale spots in a triangle at end of second radial cell similar to the triangle in distal half of cell; mesonotum with pattern of punctiform brown dots.
venezuelensis Ortiz and Mirsa (part) (p. 372)
 Cell R_5 with two small round pale spots, often partially fused, at end of and behind second radial cell; mesonotum with pattern of large patches **guyanensis** Floch and Abonnenc (p. 370)
- 58 (56). Cell R_5 with four small, round pale spots arranged in a rhomboid in midregion; no small pale spot at apex of cell R_5 ; anal cell with two distal pale spots; mesonotum with prominent pattern; halter knob dark **propriipennis** Macfie (p. 412)
 Cell R_5 with a small round pale spot at apex, as well as other proximal pale spots 59
59. Cell R_5 with subapical pale spot round or reniform, not attaining wing margin; a double pale spot at end of second radial cell; anal cell with one distal pale spot; mesonotum without prominent pattern.
paraensis (Goeldi) (p. 440)
 Cell R_5 with subapical pale spot irregular, usually extending to anterior wing margin; three small round spots beyond and behind second

- radial cell; anal cell with two distal pale spots; mesonotum with prominent pattern **lanei** Ortiz (p. 374)
- 60 (54). Cell M_2 with one pale spot distal to level of base of mediocubital fork, not counting any spot lying immediately anterior to base of fork 61
- Cell M_2 with two (or one with at least part of a second) pale spots lying distal to level of mediocubital fork 77
61. Cell R_5 with a U-shaped pale spot (sometimes reduced to two separate, round spots) enclosing a small, round, dark spot just behind second radial cell; crossvein r-m usually dark; mesonotum uniformly dark brown **acotylus** Lutz (p. 367)
- Cell R_5 without pale area enclosing a round, dark spot behind second radial cell; crossvein r-m pale 62
62. Distal pale spot in cell M_1 not attaining wing margin 63
- Distal pale spot in cell M_1 broadly attaining wing margin; distal pale spot in cell R_5 large, filling apex of cell; wing very hairy; third palpal segment bulbous; one pale spot at apex of anal cell
- magnipalpis** Wirth and Blanton (p. 360)
63. Anal cell with two distal pale spots 64
- Anal cell with one distal pale spot. 67
64. Crossvein r-m with pale spot small and lying entirely on distal side of vein, not reaching anterior wing margin; cell R_5 with one small transverse pale spot distal to the poststigmatic pale spots.
- mirsae** Ortiz (p. 446)
- Crossvein r-m lying entirely within a pale spot which reaches anterior wing margin 65
65. Halter knob dark (only at base in *tetrathyrus*); no pale spots lying next to anterior sides of veins M_1 and M_2 near bases 66
- Halter entirely pale; small, elongate pale spots present adjoining anterior sides of veins M_1 and M_2 near bases; cell R_5 with an oblique double poststigmatic pale spot and a single large round pale spot past it in middle of cell; hind femur with subapical ring and hind tibia with broad apex pale . . . **poikilonotus** Macfie (part) (p. 337)
66. Cell R_5 with four, small, round pale spots arranged in a rhomboid in midregion; r-m crossvein pale; apices of hind femur and tibia dark.
- tetrathyrus**, new species (p. 409)
- Cell R_5 with three small, round, pale spots arranged in a triangle in midregion; r-m crossvein dark; hind femur with subapical ring and hind tibia with apex pale **lyrinotatus** Wirth and Blanton (p. 391)
- 67 (63). Mesonotum with prominent pattern of punctiform brown dots; three small round, equidistant pale spots in a triangle in cell R_5 ; halter knob dark at base; two spermathecae; eye bare; antennal segments in a continuous series, sensoria on segments III, VII-X.
- ginesi** Ortiz (p. 450)
- Mesonotum with prominent pattern of large patches or without prominent pattern 68
68. Smaller species (wing 0.65 mm. long); distal pale spot in cell R_5 large and rounded, nearly filling cell from wing margin to vein M_1 ; macrotrichia sparse, only a few in apices of cells R_5 , M_1 and M_2 ; antennal segment XI shorter than x 69
- Larger species (wing 0.8-1.4 mm. long); distal pale spot in cell R_5 usually transverse, not nearly filling breadth of cell; macrotrichia more numerous, present at least on distal half of wing; antennal segment XI equal to or longer than x 71

69. Poststigmatic pale spots in cell R_3 usually fused and extending nearly to vein M_1 , the posterior portion at same level with or extending slightly distad of the anterior part; macrotrichia present on extreme apex of wing 70
- Poststigmatic pale spots in cell R_3 usually small and distinctly separated, the posterior one located distinctly proximad of the anterior spot; macrotrichia present on distal third of wing; one spermatheca present; male genitalia with well-developed ventral lobe on paramere. **fieldi**, new species (p. 427)
70. One spermatheca present; legs darker; male genitalia with stem of paramere gradually curved at base, swollen near apex of straight portion and abruptly narrowed to filiform tip. **glabellus** Wirth and Blanton (p. 429)
- Two spermathecae present; legs paler; male genitalia with stem of paramere abruptly bent and swollen near base, gradually tapered to fine tip **gabaldoni** Ortiz (p. 431)
- 71 (68). Large species (wing 1.45 mm. long), with narrow convex mesonotum with prominent yellowish and brown patches; antennal ratio 1.07, sensoria present on segments III, VII-X. **volcanensis**, new species (part) (p. 389)
- Smaller species (wing 0.72-1.02 mm. long) with broader mesonotum; antennal ratio 0.79-0.89 or 1.85 72
72. Second radial cell unusually broad; pale spot at end of costa well separated from spot behind second radial cell, farther from it than from the distal pale spot in cell R_3 which is narrow and transverse; pale distal spot in anal cell elongated, extending caudad nearly to wing margin; eye bare; antennal sensoria on segments III, VII-X; larger species (wing 1.02 mm. long) **glabrior** Macfie (p. 452)
- Second radial cell not unusually broad; antennal sensoria present on segments III, VIII-X or on III, X-XIV 73
73. One spermatheca present; antennal ratio 1.85, last five segments greatly elongated, sensoria present on segments III, X-XIV; mesonotum brownish without definite pattern. **patulipalpis**, new species (p. 421)
- Two spermathecae present; antennal ratio about 0.8, last five segments not much longer than preceding series, sensoria present on segments III, VIII-X; mesonotum blackish with prominent pattern 74
74. Wing with macrotrichia extending in two rows to base of cell M_1 ; poststigmatic pale spots in cell R_3 lying closer together with the posterior one located slightly proximad of the other; third palpal segment long and slender, about 2.2 times as long as broad, with a small, deep pit **debilipalpis** Lutz (p. 442)
- Wing with macrotrichia confined to distal half; poststigmatic pale spots in cell R_3 usually well separated and situated at same level; third palpal segment short and swollen, 1.6 times as long as broad. 75
75. Pale spot present in front of mediocubital fork; third palpal segment with a deep round pit 76
- Pale spot absent in front of mediocubital fork; third palpal segment without pit, the sensoria scattered on surface . **imitator** Ortiz (p. 438)
76. Eyes separated by a wedge-shaped space; antennal ratio 0.79; third palpal segment 1.6 times as long as broad; 14 mandibular teeth; male aedeagus with three subequal distal lobes, ninth tergum with large apicolateral processes **hoffmani** Fox (p. 436)

- Eyes separated by a parallel-sided space; antennal ratio 0.84; third palpal segment 1.8 times as long as broad; 13 mandibular teeth; male aedeagus with truncated, simple apex, ninth tergum with small apicolateral processes **spurius**, new species, (p. 433)
- 77 (60). Distal pale spot in cell M_1 broadly reaching wing margin 78
- Distal pale spot in cell M_1 not reaching wing margin, or if connected to margin by a narrow pale line, the mesonotum with punctiform brown dots 83
78. Distal part of anal cell with one definite pale spot located far from wing margin; mesonotum uniformly pruinose brown, without prominent pattern 79
- Distal part of anal cell with two, partially coalesced pale spots, the posterior one broadly meeting wing margin; mesonotum with or without pattern 80
79. Femora stout; second radial cell long with broad lumen, over twice as broad as long; costa extending to 0.78 of wing length; antennal ratio 0.61 **caprilesi** Fox (p. 456)
- Femora slender; second radial cell short, costa extending to 0.61 of wing length; antennal ratio 0.95 **wokei** Fox (p. 363)
80. Small pale brown species with poorly marked wing, mesonotum and legs; femora stout; second radial cell long with broad lumen, over twice as long as broad; costa extending to 0.69 of wing length; antennal ratio 1.25 **almirantei**, new species (p. 454)
- Well-marked, yellow and dark brown species with femora slender; second radial cell less than 1.5 times as long as broad 81
81. Cell R_5 with a large U-shaped poststigmatic pale spot cutting off an isolated small round dark spot behind second radial cell; large, slender, yellowish brown species with conspicuous brown mesonotal pattern with large yellowish patches (wing 1.14 mm. long)
- dicrourus** Wirth and Blanton (part) (p. 386)
- Cell R_5 without an isolated small, round dark spot behind second radial cell; smaller, stouter species with yellowish mesonotum bearing a pair of brown bands (wing 0.80–0.83 mm. long) 82
82. Hind femur with narrow subapical and hind tibia with broad apical pale rings **limai** Barretto (part) (p. 352)
- Hind femur and tibia entirely dark on apices
- galindoi** Wirth and Blanton (part) (p. 349)
- 83 (77). Cell R_5 with a U-shaped pale spot enclosing a small round dark spot behind second radial cell and larger, irregularly rounded, pale subapical spot broadly attaining wing margin; mesonotum bluish pruinose on sides; halter knob dark 84
- Cell R_5 without complete U-shaped pale spot enclosing a small round dark spot behind second radial cell; veins M_1 and M_2 entirely dark except possibly for small pale spots at wing margin or a line bordering distal fourth of vein M_1 only 85
84. Veins M_1 and M_2 both pale bordered on distal fourth; mesonotum with submedian anterior pale spots contrasting yellowish, lateral spots bluish **mojingaensis** Wirth and Blanton (p. 379)
- Vein M_1 only with a pale border on distal fourth, vein M_2 dark to apex; mesonotum with submedian as well as the lateral spots bluish pruinose **azureus**, new species (p. 377)

- 85 (83). Anal cell with one distal pale spot. 86
 Anal cell with two distal pale spots, which may be more or less coalesced in a double spot 88
86. Cell R_5 with five separate pale spots, the distal one lying far from wing margin; mesonotum with a prominent pattern of punctiform brown dots; legs largely pale **aureus** Ortiz (p. 447)
 Cell R_5 with three pale spots, the distal one nearly or quite broadly attaining wing margin; mesonotum without pattern or with pattern of large patches; legs dark 87
87. Cell R_5 with distal pale spot in form of an oblique double spot broadly meeting wing margin anteriorly; r-m crossvein pale; mesonotal pattern of large pale and dark patches **fluvialis** Macfie (p. 407)
 Cell R_5 with distal pale spot rounded with narrower pale extension barely attaining wing margin anteriorly; r-m crossvein with a prominent dark spot; mesonotum rusty red, without prominent pattern. **carsiomelas** Wirth and Blanton (p. 365)
- 88 (85). Cell R_5 with one or more pale spots in distal half, past the poststigmatic pale spots; second radial cell short as usual; crossvein r-m pale . . 89
 Cell R_5 without pale spot in distal half; with two round poststigmatic pale spots, one anterior to the other, and two smaller pale spots behind the greatly elongated second radial cell. **macrostigma** Wirth and Blanton (p. 395)
89. Mesonotum with pattern of punctiform brown dots; distal pale spot in cell M_1 often with very narrow extension to wing margin; distal pale spot in cell R_5 with an oblique, narrow extension to wing margin . 90
 Mesonotum uniformly dark brown or with pattern of large dark and pale patches; distal pale spot in cell M_1 never connected to wing margin; distal pale spot in cell R_5 otherwise 91
90. Mesonotal pattern obscure, center of mesonotum not yellowish; antennal segment VII with sensoria. **barbosai** Wirth and Blanton (p. 400)
 Mesonotal pattern well defined, center of mesonotum yellowish; antennal segment VII without sensoria. **gorgasi** Wirth and Blanton (p. 402)
- 91 (89). Cell R_5 with a separate fourth or fifth pale spot meeting the anterodistal wing margin in full breadth and which may be narrowly connected (in *leopoldoi*) to a pale spot lying in front of vein M_1 past middle of cell; apices of veins M_1 , M_2 and M_{3+4} ending in a pale spot; mesonotum with conspicuous pattern 92
 Cell R_5 without a separate fourth pale spot past the usual pale spot in middle of cell, or if present it meets the wing margin rarely and not in full breadth; apices of veins M_1 (except in *castillae* and *balsapambensis*), M_2 and M_{3+4} dark; mesonotum with or without pattern . . 93
92. Cell R_5 with discal pale spot small and round and never with extension to the anterior poststigmatic pale spot or to the distal spot at wing margin; discal mesonotal pattern of four pale spots arranged in a four-leaf clover design **reticulatus** Lutz (p. 393)
 Cell R_5 with discal poststigmatic pale spot irregular in shape with connections always to the distal spot at wing margin and often an extension to a fifth small pale spot near vein M_1 lying behind the anterior poststigmatic pale spot; discal mesonotal pattern with principal pale areas arranged in a transverse row, each pale area containing a few small brown punctiform dots **leopoldoi** Ortiz (p. 418)

- 93 (91). Vein M_1 with small pale spot at wing margin; antennal sensoria present on segments III, VII-X; two spermathecae present; distal pale spot in R_5 with narrow extension to wing margin.
volcanensis, new species (part) (p. 389)
 Vein M_1 dark to apex or pale margined on distal half 94
94. Vein M_1 pale margined on its distal half; cell R_5 with distal pale spot entire, not appearing double or divided; antenna with five distal segments not elongated or bearing sensoria; one or two spermathecae.
 95
 Vein M_1 dark to apex; cell R_5 with distal pale spot transverse or divided more or less into two separate spots; antenna with five distal segments elongated and bearing sensoria; one spermatheca 96
95. Cell M_2 with apical and preapical pale spots broadly connected along posterior edge of vein M_2 ; cell R_5 with distal pale spot extending broadly to wing margin; two spermathecae.
halsapambensis Ortiz and Leon (p. 414)
 Cell M_2 with apical and preapical pale spots not connected; cell R_5 with distal pale spot not attaining wing margin; one spermatheca.
castillae Fox (p. 416)
- 96 (94). Cell R_5 with distal pale spot oblique and double or completely divided into two separate spots; palpus with round pit; antennal segment x without sensoria; wing not so hairy, base of cell M_2 bare.
transferrans Ortiz (p. 424)
 Cell R_5 with distal pale spot transverse and entire; posterior poststigmatic pale spot greatly reduced; palpus with irregular pit; antennal segment x with sensoria; wing very hairy, with dense long hairs extending to base of cell M_2 . . . **rangeli** Ortiz and Mirsa (p. 423)

Subgenus *Culicoides* (*Hoffmania*) Fox

Culicoides (*Hoffmania*) Fox, 1948, Proc. Biol. Soc. Washington, vol. 16, p. 21.—Ortiz, 1950, Rev. Sanid. Asist. Soc., vol. 15, p. 437.—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 305. (Type: *Culicoides inamollae* Fox and Hoffman, by original designation.)

Species with the second radial cell ending in a pale area; base of cell M_4 pale where it borders the veins at the base of the mediocubital fork or with apices of veins M_1 , M_2 , M_{3+4} and Cu_1 pale; r-m crossvein often more or less darkened; antennal sensoria present on segments III, XI-XV or III, V, VII, IX, XI-XV; tibial comb with 5-6 spines; male genitalia with the apicolateral processes small or absent, dorsal and ventral roots of the basistyle undeveloped; aedeagus with a proximal barlike sclerotization or marginal band and usually a distal peg with a spherical tip.

There are two distinct groups of this subgenus in Panama: the *hylas* group (below) and the *guttatus* group (p. 280).

The *hylas* group

This group consists of large to medium-sized species with base of cell M_4 dark where it borders the bases of veins M_{3+4} and Cu_1 , pale

spot present anterior to base of vein M_1 ; apices of veins M_1 and M_2 and usually of veins M_{3+4} and Cu_1 pale; antennal sensoria present on segments III, XI–XV; six spines in hind tibial comb; male parameres fused basally for over half their lengths, the bases joined in a broad, platelike structure.

PANAMA SPECIES: Three: *heliconiae* Fox and Hoffman, *hylas* Macfie, and *verecundus* Macfie.

1. *Culicoides heliconiae* Fox and Hoffman

FIGURE 4

Culicoides sp. Fox, 1942, Puerto Rico Journ. Pub. Health Trop. Med., vol. 17, p. 418 (pupa; Venezuela; fig. respiratory horn, anal segment).

Culicoides heliconiae Fox and Hoffman, 1944, Puerto Rico Journ. Pub. Health Trop. Med., vol. 20, p. 108 (male, female; Maracay, Venezuela; reared from bromeliads; fig. wing).—Fox, 1948, Proc. Biol. Soc. Washington, vol. 61, p. 22 (male, female; fig. palpus, male aedeagus, parameres; Trinidad, Honduras).—Ortiz, 1950, Rev. Sanid. Asist. Soc., vol. 15, p. 450 (discussion).—Wirth and Blanton, 1956a, Journ. Washington Acad. Sci., vol. 46, p. 95 (male, female; fig. wing, palpus, spermathecae, male genitalia; synonym, *rozeboomi*).

Culicoides rozeboomi Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 26 (male, female; Trinidad, Peru, Panama; fig. palpus, mesonotum, wing, male genitalia).

Culicoides verecundus Macfie of Ortiz, 1942, Rev. Sanid. Asist. Soc., vol. 17, p. 259 (male, female; Miranda, Venezuela; fig. female antenna, spermathecae, wing, male palpus, genitalia; *verecundus* Macfie [= *palpalis* Macfie], ? = *heliconiae* Fox and Hoffman).

FEMALE: Length of wing 1.46 (1.22–1.68, $n=26$) mm.

Head.—Eyes bare, contiguous. Antenna with flagellar segments in proportion of 22:20:20:20:20:20:20:20:25:26:32:34:48, antennal ratio 1.04–1.09; distal sensory tufts present on segments III, XI–XV. Clypeus much elongated, bases of palpi arising far below level of ventral eye margin. Palpal segments in proportion of 6:21:30:15:12, third segment slender, 3.3 (2.8–5.7, $n=18$) times as long as greatest breadth, without sensory pit. Mandible with 23 (18–26, $n=26$) teeth.

Thorax.—Blackish, mesonotum with large median area and other small areas dark pruinose gray, lateral margins and a sublateral pair of short bands velvety black; humeri whitish. Legs black; mid knee narrowly pale on each side of joint, fore femur with subapical, fore tibia with subbasal and hind tibia with basal and apical, narrow pale rings; hind tibial comb with 6 spines, the second from the spur the longest.

Wing.—Pattern as figured, apices of veins M_{3+4} and Cu_1 usually pale, the pale spot in cell M_4 continued proximad along vein M_{3+4} to base of fork. Macrotrichia sparse in apices of cells R_5 , M_1 and M_2 ;

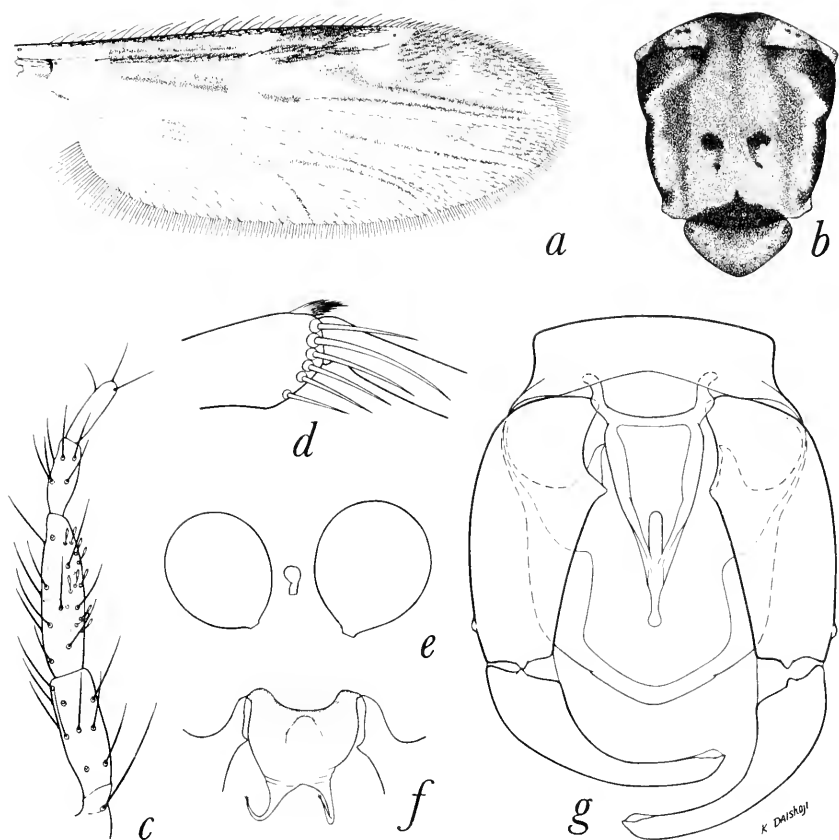


FIGURE 4.—*Culicoides heliconiae* Fox and Hoffman. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

costa extending to 0.68 of distance to wing tip. Halter yellowish white.

Abdomen.—Black, cerci yellowish. Spermathecae two, slightly ovoid, unequal, measuring 0.065 by 0.053 mm. and 0.051 by 0.042 mm.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum rounded caudad, without apicolateral processes. Basistyle with ventral and dorsal roots not developed, mesal margin without spinose setae. Aedeagus twice as long as basal width, transverse sclerotized band strong, apex with internal peg and slender, spherical tip. Parameres fused on basal two-thirds, fused part slightly broader than long, bases of free portions widely separated, free portions extremely slender, almost filiform and minutely pubescent at their tips.

DISTRIBUTION: Venezuela; Honduras; Panama; Peru; Trinidad.

PANAMA RECORDS:

CANAL ZONE: Albrook Field, Fort Kobbe (horse trap), Fort Sherman, Loma Boracho, Madden Dam.

CHIRIQUÍ PROVINCE: David, Tortugas, Volcán.

COCLÉ PROVINCE: El Valle, Penonomé.

PANAMÁ PROVINCE: Cerro Campana, Tocumen.

DISCUSSION: The synonymy of *rozeboomi* Barbosa with *heliconiae* was made by Wirth and Blanton (1956) after a comparison of the respective holotypes. This species has been reared at least three times from water-holding plants such as *Heliconia* in Venezuela (Fox, 1942), Honduras (Fox, 1948) and Trinidad (Wirth and Blanton, 1956). It is one of those species most frequently taken in stable traps and must be very strongly attracted to horses, unlike its close relatives *hylas* Macfie and *verecundus* Macfie.

2. *Culicoides hylas* Macfie

FIGURE 5

Culicoides hylas Macfie, 1940, Ent. Monthly Mag., vol. 76, p. 26 (female; British Guiana; fig. wing).—Wirth and Blanton, 1956, Journ. Washington Acad. Sci., vol. 46, p. 98 (male, female; fig. wing, palpus, spermathecae, parameres).

FEMALE: Length of wing 1.19 (0.99–1.29, $n=24$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 25:20:20:20:20:20:20:22:30:30:37:39:53, antennal ratio 1.12 (1.06–1.15, $n=5$); distal sensory tufts present on segments III, XI–XV. Clypeus not elongated, bases of palpi arising at level of ventral eye margins. Palpal segments in proportion of 8:30:50:23:17, third segment slightly swollen, 3.1 (2.6–3.6, $n=17$) times as long as greatest breadth, with shallow subdivided pit, which is often completely divided into two, small, separate, round pits. Mandible with 19 (17–21, $n=26$) teeth.

Thorax.—Dark brown, mesonotum with median area yellow and a pair of brownish black, broad, sublateral vittae; humeri blackish. Legs brownish black; fore and mid knee spots black, with adjacent narrow yellow rings on femora and tibiae, hind femur entirely dark, hind tibia with narrow pale rings at base and apex; hind tibial comb with six spines, the second from the spur longest.

Wing.—Pattern as figured, apices of veins M_1 and M_2 and in some specimens ends of veins M_{3+4} and Cu_1 pale, and pale spot in cell M_4 not continued proximad along vein M_{3+4} , extent of other pale markings somewhat variable. Macrotrichia fairly numerous in apices of cells R_5 , M_1 and M_2 and very sparse in cell M_4 and anal cell; costa extending to 0.68 of distance to wing tip. Halter whitish.

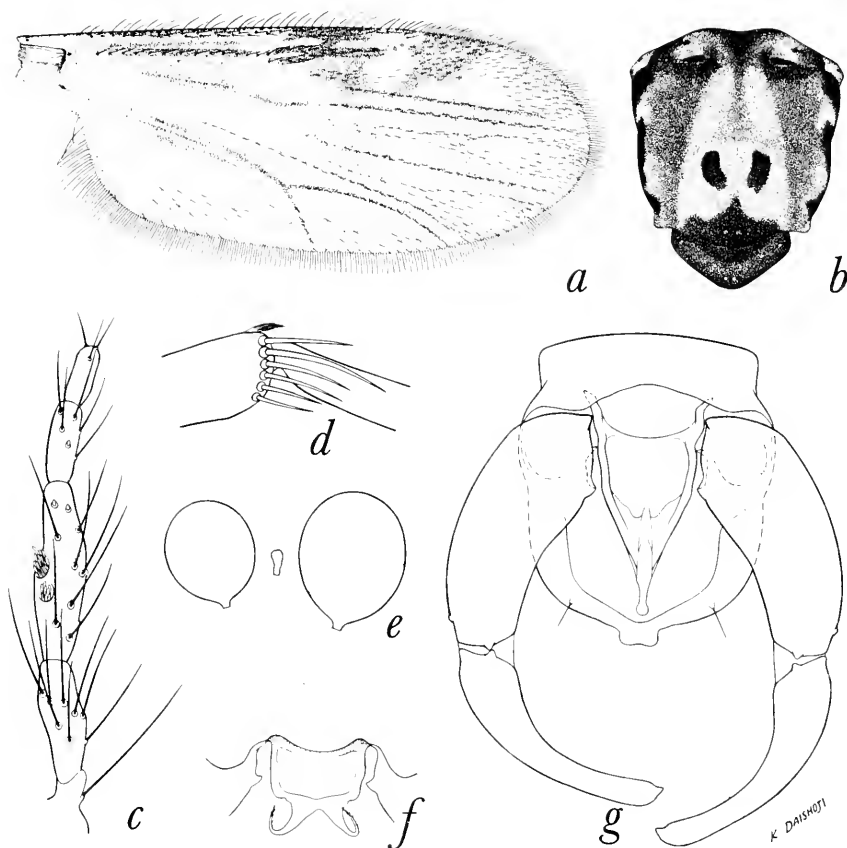


FIGURE 5.—*Culicoides hylas* Macfie. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Abdomen.—Blackish, cerci yellow. Spermathecae two, slightly ovoid, unequal, measuring 0.057 by 0.044 and 0.044 by 0.038 mm.

MALE GENITALIA: Indistinguishable from those of *heliconiae*, except for the shape of the base of the parameres, which in *hylas* is much shorter and more quadrate, about twice as broad as long.

DISTRIBUTION: British Guiana; Honduras; Nicaragua; Panama; Peru.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Albrook Field, Balboa, Barro Colorado Island (bred from *Calathea violacea*), Cabima, Fort Clayton, Fort Davis, Fort Kobbe, Fort San Lorenzo, Fort Sherman, Galeta Point, Gamboa, Huile Sia Clara (?), Loma Boracho, Madden Dam, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Algarrobo, Chiriquí, Concepción, David, Tortugas.

COCLÉ PROVINCE: Chiru, Coclé, El Retiro, El Valle, Puerto Pasado, Puerto Farallón, Penomóné, Río Hato, La Venta.

COLÓN PROVINCE: Cativá, Pilón, Piña, Salud.

DARIÉN PROVINCE: Garachiné, Jaqué.

LOS SANTOS PROVINCE: Pan de Azúcar.

PANAMÁ PROVINCE: Alcalde Díaz, Arraiján, Camarón, Cerro Campana, Chepo, El Coco, Isla Taboga, La Jolla, Pacora, Río Las Lajas, Venado Beach, Vique Cove.

VERAGUAS PROVINCE: Sapotilla.

DISCUSSION: The smaller size, black mid knees, hind femur dark at apex, sensory pits on the palpus will distinguish *hylas* from *heliconiae* and *verecundus*.

3. *Culicoides verecundus* Macfie

FIGURE 6

Culicoides verecundus Macfie, 1948, Ann. Trop. Med. Parasit., vol 42, p. 76 (male, female; Chiapas, Mexico; fig. wing).—Wirth and Blanton, 1956, Journ. Washington Acad. Sci., vol. 46, p. 98 (male, female; synonyms, *palpalis*, *contubernalis*; fig. wing, palpus, spermathecae, parameres).

Culicoides palpalis Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 78 (female, Chiapas, Mexico).

Culicoides rozeboomi var. *contubernalis* Ortiz and Leon, 1955, Bol. Inf. Cient. Nac. Ecuador, vol. 67, p. 574 (?) (female; Ecuador; fig. wing, antenna, palpus, spermatheca).

FEMALE: Length of wing 1.31 (1.16–1.42, $n=19$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 25:20:20:20:20:20:20:22:30:31:36:38:53, antennal ratio 1.10 (1.01–1.19, $n=7$); distal sensory tufts present on segments III, XI–XV. Clypeus elongated, palpus arising much below level of ventral eye margins. Palpal segments in proportion of 10:50:57:25:20, third segment very slender, 4.2 (3.2–5.2, $n=15$) times as long as greatest breadth, without sensory pit. Mandible with 23 (22–27, $n=19$) teeth.

Thorax.—Mesonotum dark brown, yellowish medially, with subshining brown sublateral vittae, and blackish along anterior and lateral margins; humeri whitish. Scutellum, postscutellum and pleuron dark brown. Legs dark brown; fore and hind knee spots blackish, their femora with broad subapical pale bands and their tibiae with broad basal pale bands; mid femur with apex and mid tibia with base broadly yellow, sometimes a very small black spot on apex of mid femur; hind tibia with apex narrowly pale; hind tibial comb with six spines, the second from the spur longest.

Wing.—Pattern as figured; pale markings more extensive than in *hylas* and *heliconiae*, but apices of veins M_{3+4} and Cu_1 always dark, pale spot in cell M_4 continued proximad along vein M_{3+4} to base of

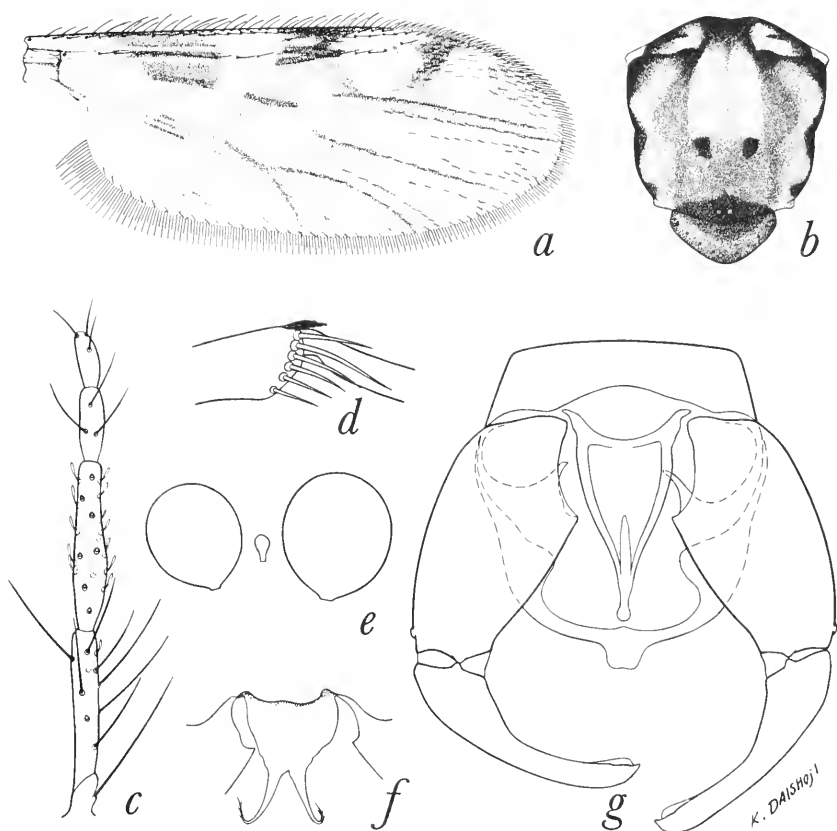


FIGURE 6.—*Culicoides verecundus* Macfie. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

fork. Macrotrichia sparse in apices of cells R_5 and M_1 ; costa extending to 0.70 of distance of wing tip. Halter whitish.

Abdomen.—Blackish, cerci yellow. Spermathecae two, slightly ovoid, unequal, measuring 0.053 by 0.044 mm. and 0.044 by 0.037 mm.

MALE GENITALIA: As in *heliconiae*, but parameres with fused basal portion about as broad as long and the distal free portions not so broadly separated at their bases, which are shorter than in *heliconiae*.

DISTRIBUTION: Mexico; Ecuador; Honduras; Nicaragua; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Barro Colorado Island (from bracket fungus), Mojinga Swamp.

CHIRIQUÍ PROVINCE: David, Volcán.

COCLÉ PROVINCE: El Valle.

PANAMÁ PROVINCE: Cerro Campana, Pacora.

DISCUSSION: This species is readily distinguished from *hylas* and *heliconiae* by the subapical pale band on the hind femur and by its more brownish color with paler wing markings.

The *guttatus* group

In this group the base of cell M_4 is pale where it borders vein M_{3+4} and Cu_1 ; no pale spot anterior to base of vein M_1 ; antennal sensoria present on segments III, XI–XV or on III, V., VII, IX, XI–XV; hind tibial comb with 5 or 6 spines.

PANAMA SPECIES: Four: *diabolicus* Hoffman, *foxi* Ortiz, *insignis* Lutz, and *trinidadensis* Hoffman.

4. *Culicoides diabolicus* Hoffman

FIGURES 2, 7

- Culicoides diabolicus* Hoffman, 1925, Amer. Journ. Hyg., vol. 5, p. 294 (female; Cabima, Panama; fig. wing).—Macfie, 1932, Ann. Mag. Nat. Hist., ser. 10, vol. 9, p. 487 (Colombia); 1937 (in part), Ann. Mag. Nat. Hist., ser. 10, vol. 20, p. 7 (male, female; Trinidad).—Costa Lima, 1937, Mem. Inst. Oswaldo Cruz, vol. 32, p. 416 (fig. female palpus; Brazil, Colombia).—Adamson, 1939, Trop. Agr., vol. 16, p. 81 (Trinidad).—Kumm, Komp, and Ruiz, 1940, Amer. Journ. Trop. Med., vol. 20, p. 420 (Costa Rica).—Vargas, 1944, Rev. Inst. Salub. Enf. Trop., vol. 5, p. 163 (Mexico; fig. palpus, antenna, legs, male genitalia); 1945, *idem*, vol. 6, p. 44 (Mexico records; synonym, *filariferus* Hoffman).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 17 (Nicaragua, Guatemala, Panama, Trinidad, and Brazil).—Fox, 1948, Proc. Biol. Soc. Washington, vol. 61, p. 24 (Panama; notes; fig. palpus, male aedeagus, parameres; synonyms, *filariferus*, *pseudodiabolicus*).—Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 109 (Guatemala).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 316 (synonyms, *bimaculatus*, *ocumarensis*).
- Culicoides filariferus* Hoffman, 1939, Puerto Rico Journ. Pub. Health Trop. Med., vol. 15, p. 172 (female; Chiapas, Mexico; fig. mesonotum, wing, palpus).
- Culicoides bimaculatus* Floch and Abonnene, 1942, Inst. Pasteur Guyane Publ., vol. 49, p. 3 (female; Cayenne, French Guiana; fig. wing, palpus).
- Culicoides pseudodiabolicus* Fox, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 256 (female; Cumuto Village, Trinidad; fig. wing).
- Culicoides ocumarensis* Ortiz, 1950, Rev. Sanid. Asist. Soc., vol. 15, p. 455 (male, female; Ocumare, Venezuela; fig. wing, mesonotum, antenna, palpus, spermathecae, male genitalia).—Ortiz and Leon, 1955, Bol. Inf. Cient. Nac., No. 67, p. 571 (Ecuador; notes; fig. wing, palpus, male genitalia).
- Culicoides guttatus* of authors (misident., not Coquillett).—Macfie, 1940, Ent. Monthly Mag., vol. 76, p. 25 (British Guiana); 1948, Ann. Trop. Med. Parasit., vol. 42, p. 74 (Chiapas, Mexico).—Barbosa, 1952, Novos subsidios . . . *Culicoides* Neotrópicos, p. 15 (Ecuador; discussion).—Gibson and Ascoli, 1952, Journ. Parasit., vol. 38, p. 315 (Guatemala).—Forattini, 1955, Fol. Clin. Biol., vol. 23, p. 103 (Brazil, redescription, figs.).

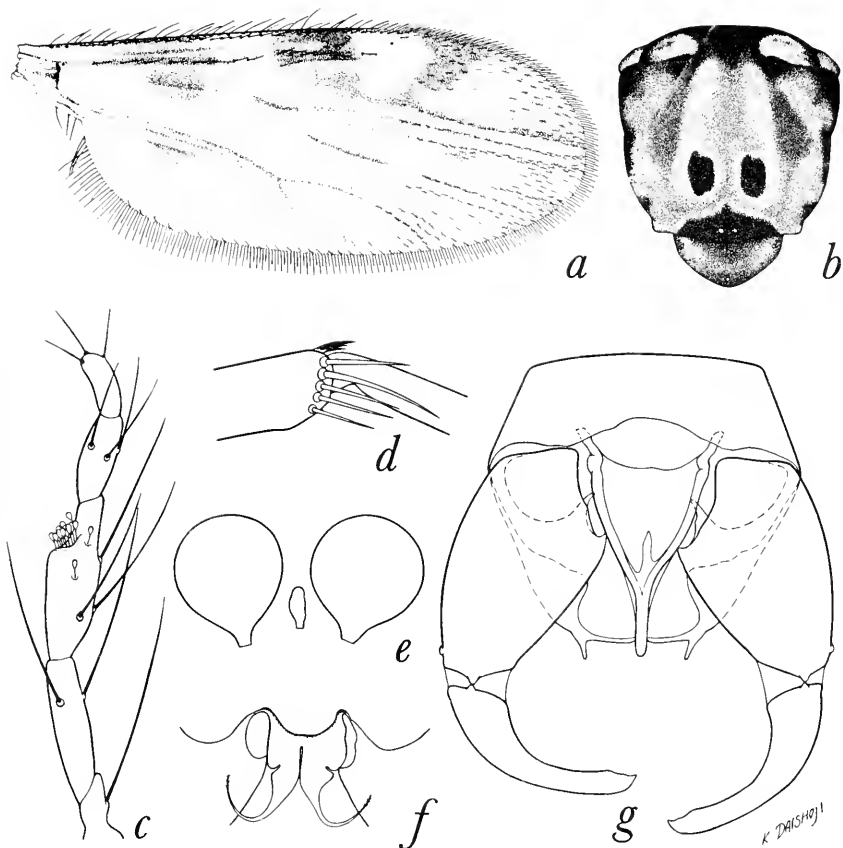


FIGURE 7.—*Culicoides diabolicus* Hoffman. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

FEMALE: Length of wing 1.03 (0.92–1.22, $n=35$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 20:15:15:15:15:15:15:16:22:22:26:30:45, antennal ratio 1.14 (1.09–1.17, $n=4$); distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 9:23:30:13:12, third segment 3.0 (2.4–3.7, $n=29$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 15 (14–18, $n=34$) teeth.

Thorax.—Mesonotum with a prominent pattern, yellowish in center, with a pair of prominent blackish sublateral vittae. Legs brown, fore and mid knees broadly yellow on femora and tibiae, hind femur dark to apex; hind tibia with broad basal and apical yellowish bands; hind tibial comb with five spines.

Wing.—Pattern as figured, crossvein r-m pale (variety *filariferus*) or dark on anterior end (typical form), vein R_{4+5} not infuscated in the pale area over the apex of second radial cell, cell M_1 with two pale spots distal to the pale spot straddling vein M_2 . Macrotrichia sparse on distal third of wing; costa extending to 0.67 (0.61–0.70, $n=35$) of distance to wing tip. Halter knob pale (typical form) or infuscated (variety *filariferus*).

Abdomen.—Blackish, cerci pale. Spermathecae two, unequal, pyriform, measuring 0.062 by 0.046 mm. and 0.053 by 0.039 mm.

MALE GENITALIA: Ninth tergum with small apicolateral processes. Aedeagus with spherical, slender tip. Parameres with bases connected by a short sclerotized loop, the apices at most with very few microscopic branches.

DISTRIBUTION: Panama; Brazil; Colombia; Costa Rica; Ecuador; French Guiana; Guatemala; Honduras; Mexico; Nicaragua; Surinam; Trinidad; Venezuela.

PANAMA RECORDS:

CANAL ZONE: Balboa, Barro Colorado Island, Cabima (type locality), Camp Butler, Caño Saddle, Fort Clayton, Fort Davis, Fort Gulick, Fort Kobbe (horse trap), Fort Sherman, France Field (horse trap), Gamboa, Loma Boracho, Madden Dam, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Gualaca, Lino, Pedregal, Río Tabasara, Volcán.

COCLÉ PROVINCE: El Valle, Río Hato.

COLÓN PROVINCE: Piña.

DARIEN PROVINCE: El Real, Garachiné, Jaqué, Punta Patiño.

HERRERA PROVINCE: Chitré.

LOS SANTOS PROVINCE: Los Tablas, La Palma.

PANAMÁ PROVINCE: Arraiján, Cerro Campana, La Jolla, Pacora, Pedregal, Isla Taboga, Tocumen, Vique Cove.

VERAGUAS PROVINCE: Río Santa María, Sapotilla.

DISCUSSION: This species is distinguished from its close relatives by its smaller size, presence of mesonotal pattern, wings with the pale markings sharp and rather extensive, vein R_{4+5} not infuscated on the portion in the pale area at apex of second radial cell, and two pale spots in cell M_1 distal to the pale spot straddling vein M_2 . Species with which it has been confused are: *foxi* Ortiz, which has a black spot on vein R_{4+5} near the apex of the second radial cell; *insignis* Lutz, which has vein R_{4+5} infuscated basally in the pale area over second radial cell to the point where it turns abruptly forward to meet the costa and only one pale spot in cell M_1 distal to the pale spot straddling vein M_2 ; and *guttatus* (Coquillett), which has no mesonotal pattern and is larger. There is some variation in the wing markings of *diabolicus*; rarely the distal spot in cell M_1 is obliterated, the crossvein r-m, which is normally pale, may be dark on the anterior end, and the halter knob, which is normally infuscated, may be pale in the

variety *filariferus* Hoffman. The proportion of this variety in the population is quite high in Venezuela (where it was described as *ocumarensis* by Ortiz) and in the Central American highlands, but elsewhere, including Panama, it seems to be relatively rare.

Culicoides diabolicus is apparently one of the commonest species annoying to man in Latin America, outside the coastal salt marshes. Dampf (1936) found it to be parasitized by developmental forms of filarid larvae in Chiapas, Mexico, but Gibson and Ascoli (1952) concluded that on account of the rarity of this species in biting collections from the human onchocerciasis zone of Guatemala, it is probably not an important vector there. Material received recently from Trinidad collected by T. H. G. Aitken and W. G. Downs indicates that *diabolicus* is one of the commonest man-biters in the mountainous parts of that island. Nothing is known of the breeding habits of *diabolicus*.

5. *Culicoides foxi* Ortiz

FIGURE 8

Culicoides foxi Ortiz, 1951, Nov. Cient. Mus. Hist. Nat. La Salle, zool. ser., no. 5, p. 4 (male, female; Caracas, Venezuela; fig. wing, mesonotum, palpus, spermathecae, male genitalia).—Fox, 1953, Journ. Econ. Ent., vol. 45, p. 888 (Puerto Rico).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 309.

Culicoides diabolicus Macfie (not Hoffman, misident.), 1935, Stylops, vol. 4, p. 54 (Tutoia, Piauí, Brazil); 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 20, p. 7 (Trinidad).—Floch and Abonnenc, 1942, Inst. Pasteur Guyane Publ., vol. 37, p. 2 (French Guiana; fig. female wing, palpus).

Culicoides guttatus Fox (not Coquillett, misident.), 1948, Proc. Biol. Soc. Washington, vol. 61, p. 23 (Brazil, Venezuela; fig. female palpus); 1949, Bull. Brooklyn Ent. Soc., vol. 44, p. 31 (Puerto Rico; female, male genitalia; fig. female wing, spermathecae, male aedeagus, parameres); 1950, Puerto Rico Journ. Pub. Health Trop. Med., vol. 25, p. 342 (Puerto Rico).

FEMALE: Length of wing 1.21 (1.01–1.33, $n=15$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 22:17:17:18:18:18:18:20:25:26:30:32:48, antennal ratio 1.10; distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 10:25:38:20:14, third segment 3.2 (2.5–3.6, $n=9$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 16 (14–17, $n=16$) teeth.

Thorax.—Mesonotum with prominent pattern, yellowish in center, with two distinct, sublateral, blackish, longitudinal vittae. Legs brown with distinct pale bands at midlength and narrow blackish rings before apex on fore and mid femora, fore and mid knees narrowly pale, hind tibia with basal and apical pale bands; hind tibial comb with six spines.

Wing.—Pattern as figured, two pale spots in cell M_1 past the pale spot straddling middle of vein M_2 , crossvein r-m blackish and a small blackish spot behind apex of second radial cell. Macrotrichia sparse

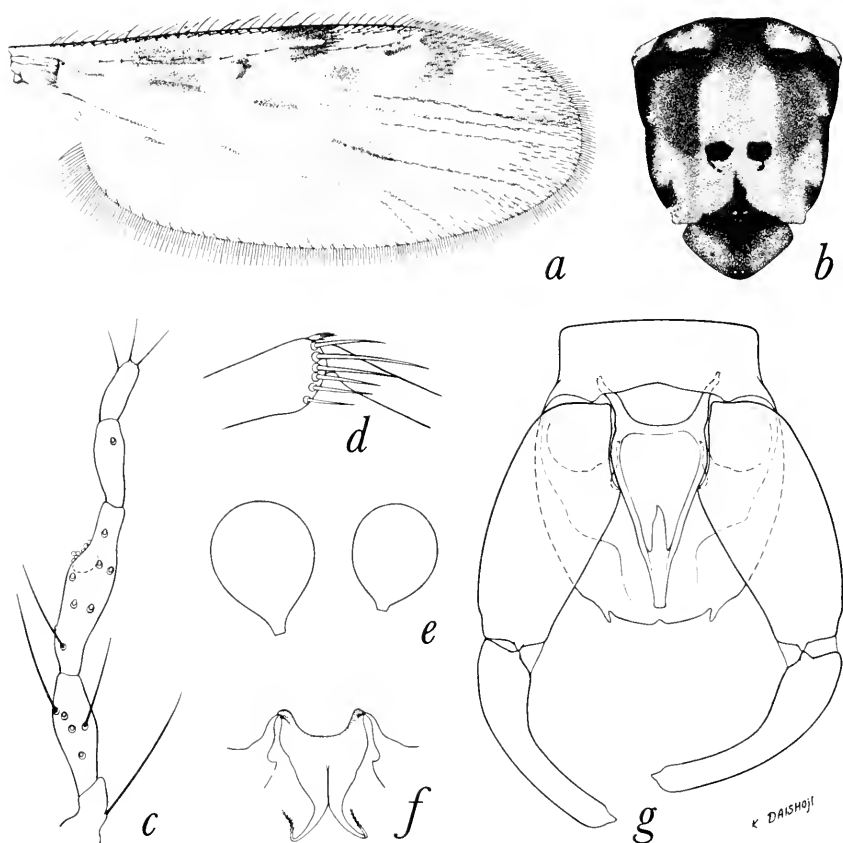


FIGURE 8.—*Culicoides foxi* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

near distal wing margin; costa extending to 0.68 (0.67–0.71, $n=15$) of distance to wing tip near distal wing margin. Halter knob blackish.

Abdomen.—Blackish, cerci pale. Spermathecae two, pyriform, unequal, measuring 0.063 by 0.049 mm. and 0.053 by 0.043 mm., with bases of ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with shallow caudomedian excavation; ninth tergum rounded caudad, with very small apicolateral processes. Aedeagus elongate, sides convexly swollen, apex truncate rather than spherical. Parameres fused on basal fourth, apices with short hairs.

DISTRIBUTION: Venezuela; Brazil; Honduras; Nicaragua; Panama; Puerto Rico.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante (Río Banana), Torres.

CANAL ZONE: Albrook Field, Barro Colorado Island, Cabina, Fort Clayton, Fort Gulick, Fort Kobbe (horse trap), Fort Sherman, France Field, Loma Boracho, Madden Dam, Mandinga River, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Pedregal, Volcán.

COCLÉ PROVINCE: Aguadulce.

COLÓN PROVINCE: Piña.

DARIÉN PROVINCE: El Real, Punta Patiño.

HERRERA PROVINCE: Chitré.

PANAMÁ PROVINCE: Arraiján, La Jolla, Tocumen.

DISCUSSION: The small, isolated dark spot near the tip of vein R_{4+5} will readily separate this species from its relatives in the subgenus *Culicoides* (*Hoffmania*).

6. *Culicoides insignis* Lutz

FIGURE 9

Culicoides insignis Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 50 (male, female, pupa; Rio de Janeiro and Bahia, Brazil; fig. female wing).—Costa Lima, 1937, Mem. Inst. Oswaldo Cruz, vol. 32, p. 415 (fig. female palpus).—Floch and Abonnenc, 1942, Inst. Pasteur Guyane Terr. l'Inini, publ. 49, p. 1 (French Guiana; fig. wing, palpus).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 20 (notes on genitalia of male in Lutz collection; fig. male genitalia from Rio de Janeiro).—Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 75 (Chiapas, Mexico).—Fox, 1948, Proc. Biol. Soc. Washington, vol. 61, p. 25 (notes on female characters).—Barbosa, 1952, Novos Subsidios . . . *Culicoides* Neotrópicos, p. 16 (Ceara, Brazil; notes on Lutz collection).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 319 (synonyms, *inamollae*, *painteri*).

Culicoides guttatus Lutz (misident., not Coquillett), 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 58 (fig. wing).—Beck, 1952, Florida Ent., vol. 35, p. 102 (Florida records).

Culicoides inamollae Fox and Hoffman, 1944, Puerto Rico Journ. Pub. Health Trop. Med., vol. 20, p. 110 (male, female; Puerto Rico; fig. wing).—Fox, 1948, Proc. Biol. Soc. Washington, vol. 61, p. 25 (Florida; fig. male aedeagus, parameres, female palpus); 1950, Puerto Rico Journ. Pub. Health Trop. Med., vol. 25, p. 342.—Foote and Pratt, 1954, Pub. Health Monogr. no. 18, p. 25 (United States records; fig. wing, mesonotum, palpus, male genitalia).—Fox, 1955, Journ. Agr. Univ. Puerto Rico, vol. 39, p. 242 (synonyms, *painteri* Fox, *oliveri* Fox and Hoffman [sic]).

Culicoides painteri Fox, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 257 (female; Honduras; fig. wing); 1948, Proc. Biol. Soc. Washington, vol. 61, p. 26 (fig. male parameres, aedeagus, female palpus).

FEMALE: Length of wing 1.11 (0.89–1.25, $n=24$) mm.

Head.—Eyes bare, contiguous. Antenna with flagellar segments in proportion of 20:14:14:14:14:14:15:24:25:26:29:44, antennal ratio 1.32; distal sensory tufts present on segments III, V, VII, IX,

xI-xv. Palpal segments in proportion of 9:23:33:13:17, third segment 2.8 (2.5-3.5, $n=19$) times as long as greatest breadth, sensory pit broad and shallow, more or less subdivided into small pitted areas. Mandible with 21 (20-23, $n=20$) teeth.

Thorax.—Mesonotum with prominent pattern, yellowish in center, two dark sublateral vittae. Legs dark brown with pale rings on fore

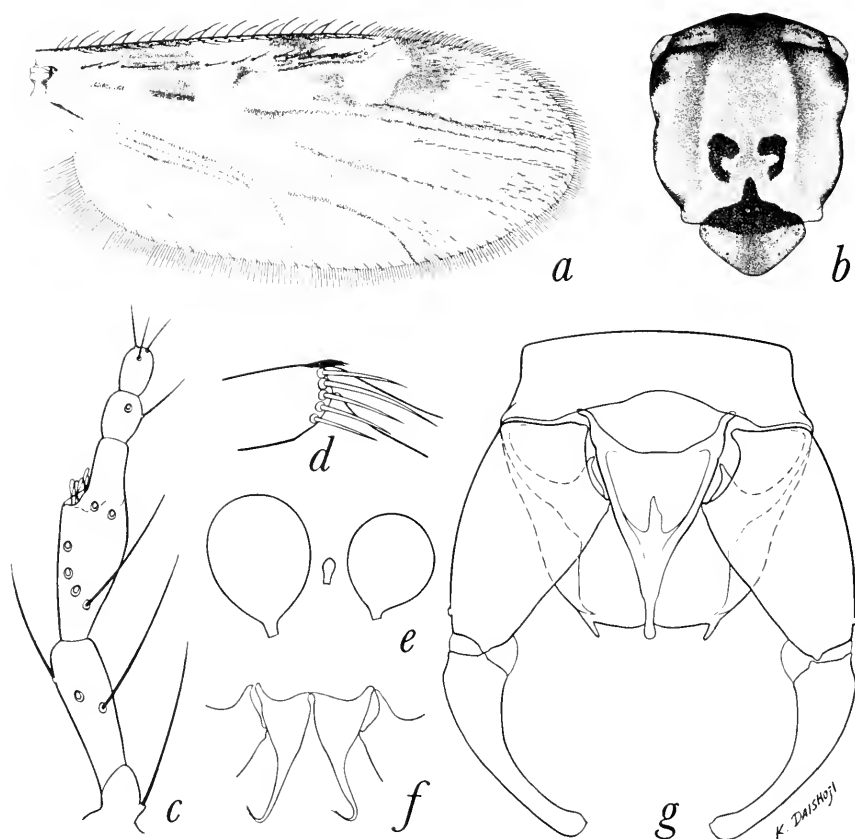


FIGURE 9.—*Culicoides insignis* Lutz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

and mid knees and at base and apex of hind tibia; hind tibial comb with six spines.

Wing.—Pattern as figured, one pale spot in cell M_1 distal to the pale spot straddling vein M_2 ; crossvein r-m dark, vein R_{4+5} dark up to the point where it turns abruptly forward to meet the costa. Macrotrichia sparse on distal half of wing and in anal cell; costa extending to 0.65 (0.63-0.68, $n=24$) of distance to wing tip. Halter knob dark.

Abdomen.—Blackish, cerci paler. Spermathecae two, subspherical to pyriform, unequal, measuring 0.063 by 0.049 mm. and 0.052 by 0.041 mm.

MALE GENITALIA: Ninth tergum with small apicolateral processes; basistyle with well-developed spinose setae on mesal margin. Aedeagus A-shaped, with slender, spherical tip. Parameres with main bodies connected at bases by a short loop, the tips bare.

DISTRIBUTION: Puerto Rico; Brazil; Colombia; Florida; French Guiana; Honduras; Jamaica; Mexico; Nicaragua; Panama; Surinam; Trinidad; Venezuela.

PANAMA RECORDS:

CANAL ZONE: Balboa, Fort Davis, Fort Gulick, Loma Boracho, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Gualaca, Volcán.

COCLÉ PROVINCE: Aguadulce, El Cristo, El Vallé, Natá, Puerto Farallón, Puerto Obaldia, Río Hato.

DARIÉN PROVINCE: El Real, Jaqué, Punta Patiño.

HERRERE PROVINCE: Chitré.

LOS SANTOS PROVINCE: Guararé, Las Tablas.

PANAMÁ PROVINCE: Arraiján, Cerro Campana, La Jolla, Pacora, San Carlos, Isla Taboga, Tocumen.

We have sunk *inamollae* and *painteri* in the synonymy of *insignis* after a comparison of the holotypes of these two species, kindly loaned to us by Dr. Fox, with syntypes of *insignis* loaned to us by Dr. Costa Lima (Wirth and Blanton, 1956). We have designated a male syntype of *insignis* from the Instituto Oswaldo Cruz collection as the lectotype of *insignis*.

The females of *insignis* are quite easily recognized by the wing markings, only one pale spot in cell M_1 past the pale spot straddling vein M_2 , r-m crossvein is dark and vein R_{4+5} is dark extending well into the pale area over the second radial cell and usually dark to the point where it bends forward abruptly toward the costa.

In Panama, *insignis* reaches its greatest abundance in muddy cowpastures as at Aguadulce and Tocumen, where it usually outnumbers all other species of *Culicoides*.

7. *Culicoides trinidadensis* Hoffman

FIGURE 10

Culicoides trinidadensis Hoffman, 1925, Amer. Journ. Hyg., vol. 5, p. 286 (female; Trinidad; fig. wing).—Fox, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 256 (Stubal's Bay, Trinidad); 1948, Proc. Biol. Soc. Washington, vol. 61, p. 23 (fig. female palpus).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 324 (synonyms, *oliveri*, *diminutus*).

Culicoides oliveri Fox and Hoffman, 1944, Puerto Rico Journ. Pub. Health Trop. Med., vol. 20, p. 108 (Haiti; male, female; fig. male aedeagus, parameres).—Fox, 1948, Proc. Biol. Soc. Washington, vol. 61, p. 23 (discussion).

Culicoides wokei Barbosa (in part, not Fox, June 1947), November 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 28 (male, female; Balboa, Panama; fig. male genitalia, female palpus).

Culicoides diminutus Barbosa, 1951, Proc. Ent. Soc. Washington, vol. 53, p. 163 (new name for *wokei* Barbosa not Fox).—Woke, 1954, Ann. Ent. Soc. Amer., vol. 47, p. 68, 71 (biological notes).

FEMALE: Length of wing 1.12 (1.06–1.19, $n=14$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 23:15:15:15:15:15:16:27:29:32:33:43, antennal ratio 1.22 (1.15–1.30, $n=5$); distal sensory tufts present on segments III, V, VII, IX, XI–XV. Palpal segments in proportion of 10:27:45:15:18; third segment 3.4 (2.8–3.9, $n=15$) times as long as greatest breadth, without sensory pit, the sensoria scattered on surface. Mandible with 17 (16–20, $n=17$) teeth.

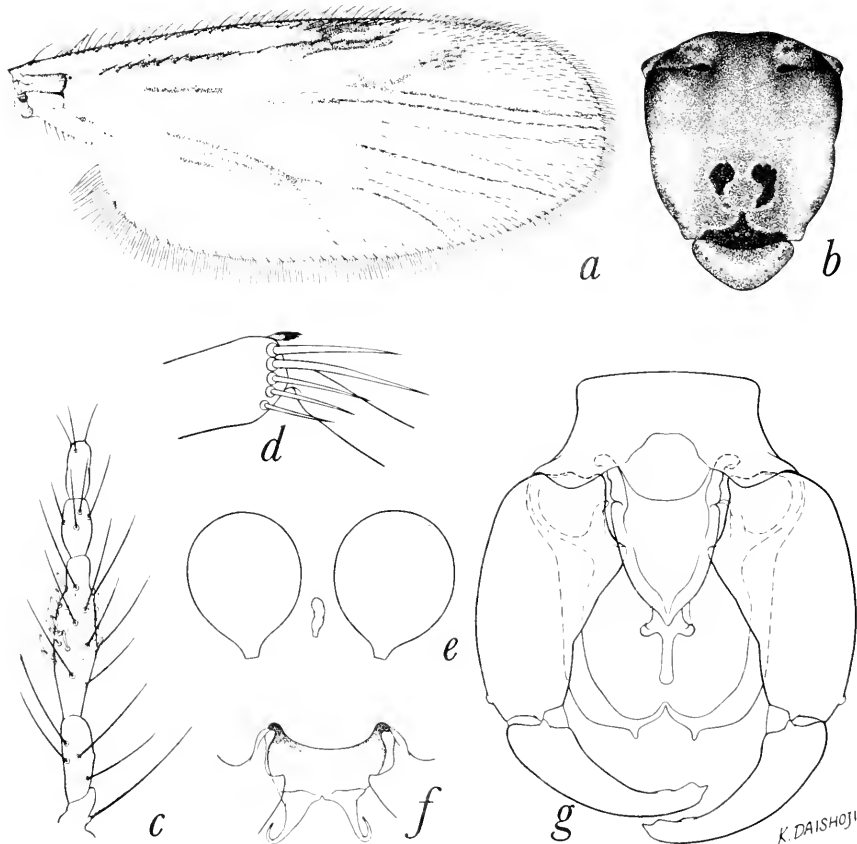


FIGURE 10.—*Culicoides trinidadensis* Hoffman. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum and scutellum uniformly dull brown, without pattern. Legs dark brown, trace of pale spots on fore and mid knees and pale bands at base and apex of hind tibia; hind tibial comb with five ($n=17$) spines.

Wing pattern as figured, grayish brown with pattern of small, dull, grayish white spots, crossvein dark on anterior end, vein R_{4+5} not darkened past the dark area over base of second radial cell, cell M_1 with only one pale spot distal to the pale spot straddling vein M_2 . Macrotrichia sparse but present in all marginal cells of wing; costa extending to 0.66 (0.63–0.70, $n=14$) of distance to wing tip. Halter dark.

Abdomen.—Blackish, cerci paler. Spermathecae two, subspherical to pyriform, subequal, measuring 0.058 by 0.046 mm.

MALE GENITALIA: Ninth tergum with distinct caudomedian cleft and small, not widely separated, apicolateral processes. Aedeagus stout, with a pair of peculiar, subapical projections extending ventro-laterad, the shape of the apex resembling a fleur-de-lis. Parameres with main bodies fused on basal half, apices filiform and bare.

DISTRIBUTION: Trinidad; Bahama Islands, Haiti, Nicaragua, Panama.

PANAMA RECORDS:

CANAL ZONE: Balboa (type locality of *wokei* Barbosa), Fort Kobbe, Galita Point, Loma Boracho, Mojinga Swamp.

BOCAS DEL TORO PROVINCE: Almirante.

CHIRIQUÍ PROVINCE: Alanje, Río Tabasará.

COCLÉ PROVINCE: Puerto Farallón, Puerto Obaldía, Río Hato.

DARIÉN PROVINCE: Garachiné, Jaqué, Punta Patiño.

HERRERA PROVINCE: Puerto Chitré.

LOS SANTOS PROVINCE: Las Tablas.

PANAMÁ PROVINCE: Arraiján, Bayano, Chame, Pedregal, Puerto de Chorrera, Río Las Lajas, Tocumen, Viqué Cove.

Archipiélago de las Perlas: Isla del Rey.

DISCUSSION: This species is known only from localities near coastal salt marshes. It greatly resembles the Brazilian species, *maruim* Lutz, with its unmarked mesonotum, wing pattern with dark crossvein, undarkened vein R_{4+5} and only one distal pale spot in cell M_1 , dark halter, and third palpal segment without sensory pit, but *maruim* is a paler species with a more yellowish wing on which the macrotrichia are very scanty, lacks the sensoria on antennal segments v, vii and ix, the male aedeagus lacks the fleur-de-lis-like apex and the parameres are fused only a short distance at bases and taper more gradually to stouter, bare apices.

Woke (1954) reported this species (as *diminutus* Barbosa) from biting collections on man, and from emergence traps on the tidal

marsh at Balboa, Canal Zone. Woke's collections formed part of the type series of *diminutus* (= *wokei* Barbosa, not Fox).

Subgenus *Culicoides* (*Avaritia*) Fox

Culicoides (*Avaritia*) Fox, 1955, Puerto Rico Journ. Agr., vol. 39, p. 218.

Small species with bluish black mesonotum and pale legs; antenna with sensoria on segments III, XII or XIII to XV; tibial comb with 5 spines; male genitalia with ninth tergum rounded, apicolateral processes absent, inner margin of basistyle without spinose setae; aedeagus without basal barlike sclerotization or ball-like tip, but with distal peg; parameres separate and short with simple tips.

TYPE: *Ceratopogon obsoletus* Meigen, by original designation.

PANAMA SPECIES: Two: *pusilloides* Wirth and Blanton and *pusillus* Lutz. These species belong to a group distinct from the Holarctic *obsoletus* group and we will call this the *pusillus* group.

8. *Culicoides pusilloides* Wirth and Blanton

FIGURE 11

Culicoides pusilloides Wirth and Blanton, 1955, Bull. Brooklyn Ent. Soc., vol. 50, p. 104 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia)

FEMALE: Length of wing 0.69 (0.63–0.73, $n=10$) mm.

Head.—Eyes bare, broadly contiguous. Antenna with flagellar segments in proportion of 14:9:10:11:11:11:12:13:15:16:16:18:28, antennal ratio 1.12 (0.98–1.43, $n=8$); distal sensory tufts present on segments III, XII–XV. Palpal segments in proportion of 5:11:13:5:7, third segment slightly swollen, 1.9 (1.6–2.2, $n=9$) times as long as greatest breadth, with a small, deep sensory pit. Mandible with 13 (12–15, $n=8$) teeth.

Thorax.—Mesonotum blackish, anterior margin and two broad sublateral vittae extending the entire length of mesonotum intense black, a broad median band and sides of mesonotum behind level of humeral pits densely bluish gray pruinose. Scutellum, postscutellum and pleuron black. Legs brown, fore and mid femora with broad apical pale rings; fore tibia with narrow and mid tibia with broad, basal pale rings, hind tibia and most of tarsi yellowish; hind tibial comb with five spines, the one next to the spur longest.

Wing.—Pattern as figured, with four incomplete bands of large, diffuse, pale spots, the dark areas of wing less extensive than the pale areas, distal half of second radial cell in a pale area, each band in cell R_5 about half as broad as the pale areas on each side. Macrotrichia nearly absent, only a few along wing margin in cells R_5 and M_1 ; costa extending to 0.57 of distance to wing tip. Halter pale yellowish.

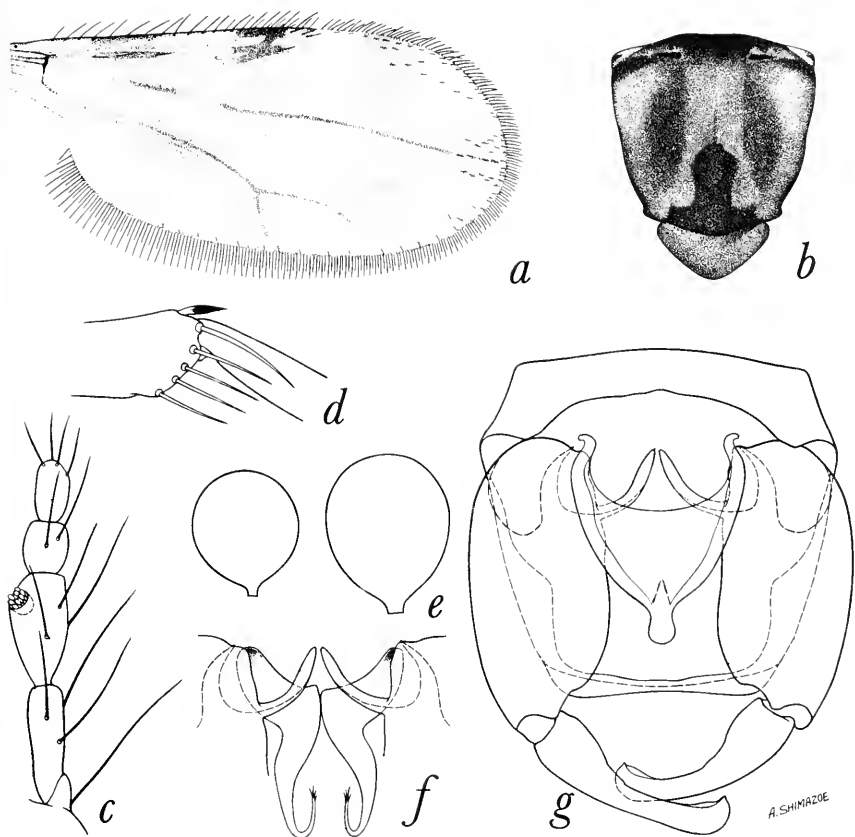


FIGURE 11.—*Culicoides pusilloides* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Abdomen.—Pale brown, darker toward apex. Spermathecae two, slightly ovoid, very unequal, measuring 0.042 by 0.034 mm. and 0.033 by 0.026 mm.

MALE GENITALIA: Ninth sternum narrow, ribbonlike; ninth tergum broader than long, slightly convex caudally, without apicolateral processes, median notch or lobes. Basistyle with ventral root long and slender, dorsal root about half as long as ventral root, pointed; dististyle with slightly expanded apex. Aedeagus 1.4 times as long as basal breadth, with basal arch reaching about 0.4 of total length, distal portion with a peglike internal sclerotization, apex papilliform. Parameres separate, each with very stout base, bulbous stem, apex very slender and recurved, with a few very fine hairs.

DISTRIBUTION: Panama; Guatemala; Honduras; Nicaragua.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante (type locality).

CANAL ZONE: Fort Kobbe, Loma Boracho, Mojinga Swamp.

CHIRIQUÍ PROVINCE: La Concepción.

PANAMÁ PROVINCE: Camarón, Pedregal.

DISCUSSION: This species is a typical member of the subgenus *Culicoides* (*Avaritia*), with the second radial cell distinctly pale on the apical half, thus easily separable from its closest relative, *pusillus* Lutz.

9. *Culicoides pusillus* Lutz

FIGURE 12

Culicoides pusillus Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 52 (male, female; Manguinhos, Rio de Janeiro, Brazil; fig. female wing).—Macfie, 1938, Proc. Roy. Ent. Soc. London, vol. 7, p. 165 (Trinidad; fig. male genitalia).—Barbosa, 1947, Anais Biol. Soc. Pernambuco, vol. 7, p. 25 (Panama, Jamaica).—Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 79 (Chiapas, Mexico).—Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 16, p. 603 (male, female; Venezuela; fig. eyes, antenna, palpus, spermathecae, wing, male genitalia).—Ortiz and Leon, 1955, Bol. Inf. Cient. Nac. Ecuador, no. 67, p. 570 (Ecuador).—Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 110 (Guatemala).

FEMALE: Length of wing 0.64 (0.56–0.69, $n=8$) mm.

Head.—Eyes narrowly contiguous, with long interfacetal hairs. Antenna with flagellar segments in proportion of 11:6:6:7:7:7:7:11:11:13:13:20, antennal ratio 1.18 (1.15–1.26, $n=7$); distal sensory tufts present on segments III, XIII–XV. Palpal segments in proportion of 5:17:19:8:8, third segment only slightly swollen, 2.6 (2.2–2.8, $n=8$) times as long as greatest breadth, with a small, deep sensory pit. Mandible with 14 (13–15, $n=10$) teeth.

Thorax.—Mesonotum blackish, densely bluish to greenish gray pruinose, with two narrow, longitudinal sublateral black vittae. Scutellum, postscutellum and pleuron blackish. Legs pale brown, knee spots blackish; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, broad pale bands; hind tibial comb with five ($n=5$) spines, the one next to the spur longest.

Wing.—Pattern as figured; large quadrate pale spots at anterior wing margin over r-m crossvein and past end of second radial cell, remainder of wing without distinct pale spots, but obscurely paler between the veins. Macrotrichia absent, costa extending to 0.53 (0.52–0.53, $n=8$) of distance to wing tip. Halter whitish.

Abdomen.—Pale brown. Spermathecae two, slightly ovoid, subequal, measuring 0.043 by 0.031 mm., the bases of the ducts sclerotized a very short distance.

MALE GENITALIA: Ninth sternum with a broad, shallow, caudo-median excavation; ninth tergum short, rounded caudad with two broadly rounded lobes, apicolateral processes absent. Basistyle with ventral and dorsal roots short, slender, subequal; dististyle with enlarged, rounded tip. Aedeagus with main body triangular, basal arms short, basal arch low and rounded, extending to about a fourth

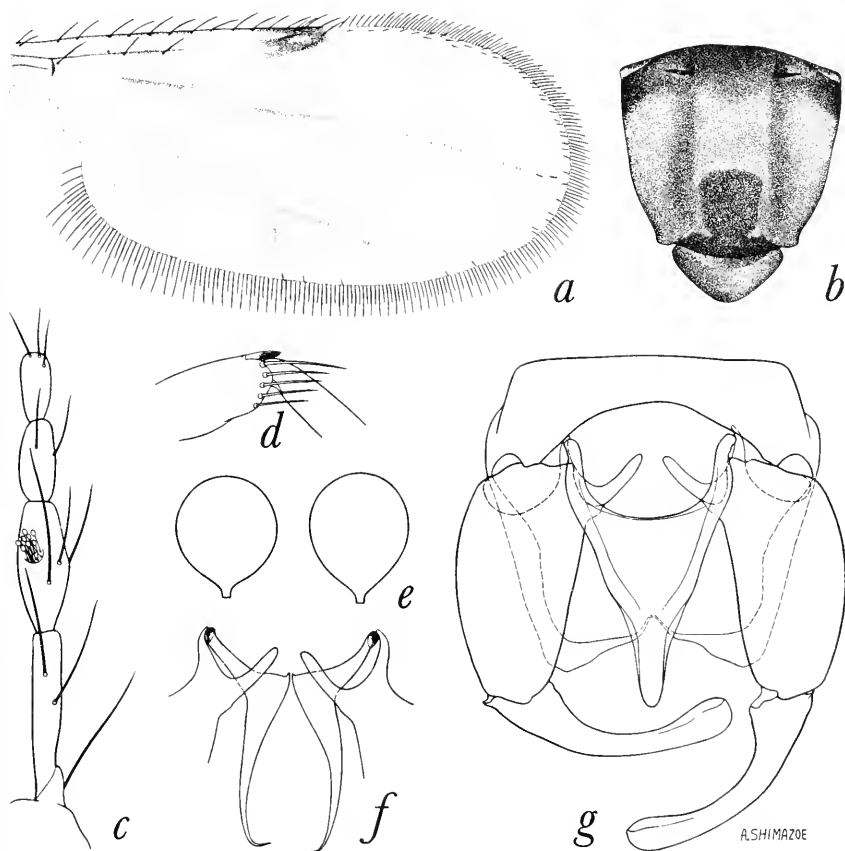


FIGURE 12.—*Culicoides pusillus* Lutz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

of total length of aedeagus, distal portion slender with a rounded apex, a distinct internal, basally projecting, sclerotized peg present. Parameres separate, each with slender anterolateral arm, base of stem stout, stem tapering to curved, filiform, simple apex.

DISTRIBUTION: Brazil; Ecuador; French Guiana; Guatemala; Mexico; Panama; Trinidad; Venezuela; West Indies.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Clayton, Fort Davis, Fort Kobbe, France Field, Loma Boracho, Mandinga River, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Algarrobo, Boca Chica, Chiriquí, Chirú, Concepción Horconcitos, Río Tabasará, Tortugas.

COCLÉ PROVINCE: Aguadulce, Antón, Coclé, El Cristo, El Valle, La Venta, Penonomé, Río Hato.

COLÓN PROVINCE: Cativá.

DARIÉN PROVINCE: El Real, Garachiné, Jaqué, Punta Patiño.

LOS SANTOS PROVINCE: Guararé, La Palma, Las Tablas, Los Cruces, Macaracas, Puerto Mensabé, La Yeguada.

PANAMÁ PROVINCE: Alcalde Díaz, Chepo, La Jolla, Pedregal, San Carlos, Isla Taboga, Tocumen.

VERAGUAS PROVINCE: Divisa, Río Santa María, San Francisco, Santiago, Sapotillo.

DISCUSSION: The small size, bare wing without marginal pale spots, the very short, entirely dark second radial cell, blackish mesonotum with two faint darker vittae and relatively pale legs will distinguish *pusillus* from other Panama species. *C. pusillus* is exceptional among the related species of the subgenus *Culicoides* (*Avaritia*) in having the apex of the very short second radial cell entirely dark or only very slightly encroached on by the poststigmatic pale spot. Structurally it is typical of the subgenus.

Subgenus *Culicoides* (*Culicoides*) Latreille

Culicoides Latreille, 1809, *Genera Crustaceorum et Insectorum* . . . , vol. 4, p. 251 (type: *Culex pulicaris* Linnaeus, as *Ceratopogon punctatus* Meigen, monobasie).

Species with the second radial cell ending in a pale area; base of cell M_4 dark at the base of the mediocubital fork and the apices of veins M_1 , M_2 , M_{3+4} and Cu_1 always dark; r-m crossvein always pale; eyes contiguous, bare; antenna with sensoria present on segments III, and XI, XII or XIII to XV.

There are three groups of the subgenus *Culicoides* in Panama: *pulicaris* (below), *covagarciai* (p. 298), and *nigrigenus* (p. 307).

The *pulicaris* group

Large species with black legs, at most with small pale knee spots; mesonotum blackish, entirely dull gray pruinose or with gray pruinose pattern; antenna with sensoria present on segments III, XI–XV; tibial comb with six spines; male genitalia with ninth tergum rounded caudally and bearing a low median lobe, the apicolateral processes small; basistyle with mesal surface more or less spinose; aedeagus without basal sclerotized band, distal peg or spherical tip; parameres separate, with bent bases and slender, pubescent tips.

This group and the *obsoletus* group of the subgenus *Culicoides* (*Aparitia*) reach their highest development in the Holarctic Region with numerous North American and Eurasian species, particularly in the far north.

PANAMA SPECIES: Two: *elutus* Macfie and *luteovenus* Root and Hoffman.

10. *Culicoides elutus* Macfie

FIGURE 13

Culicoides elutus Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 75 (female; El Carrizal, Chiapas, Mexico; fig. wing).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 212 (male, female: Panama; fig. wing, palpus, spermatheca, male genitalia).

Culicoides cockerelli tristriatulus Vargas (misident., not Hoffman), 1945, Rev. Inst. Salub. Enf. Trop., vol. 6, pp. 45, 48 (Camotlán, Oaxaca, Mexico; fig. male genitalia).

FEMALE: Length of wing 1.14 (1.02–1.25, $n=14$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 20:15:17:17:17:17:17:20:21:23:24:35, antennal ratio 0.93 (0.91–0.96, $n=2$); distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 10:26:30:12:12; third segment strongly swollen, 2.5 (2.1–2.7, $n=10$) times as long as greatest breadth, abruptly narrowed beyond the large sensory pit. Mandible with 16 (14–17, $n=14$) teeth.

Thorax.—Mesonotum and scutellum uniformly dark pruinose brown. Legs dark brown, small knee spots on all legs and narrow bands on base and apex of hind tibia yellowish; hind tibial comb with six spines, the second from the spur the longest.

Wing.—Pattern as figured, roughly in form of three dark zig-zag bands, each more or less broken into separate dark spots centering on the veins, distal pale spot in cell R_5 occupying entire apex of cell to wing margin, distal pale spots in cells M_1 and M_2 broadly meeting wing margin. Macrotrichia abundant, extending nearly to base of wing and abundant in anal cell; costa extending 0.65 way from basal arculus to wing tip. Halter yellowish white.

Abdomen.—Blackish. Spermathecae two, subequal, suboval, each measuring 0.083 by 0.053 mm.

MALE GENITALIA: Ninth sternum with deep caudomedian excavation; ninth tergum rounded caudally with moderately developed apicolateral processes and a well-developed, hyaline, uncleft, caudomedian lobe. Basistyle with dense, dark, spinose setae on mesal face, dorsal and ventral roots well developed; dististyle with expanded tip. Aedeagus massive, distal portion stout with a short, more slender, caudomedian lobe. Parameres separate, slender, each with

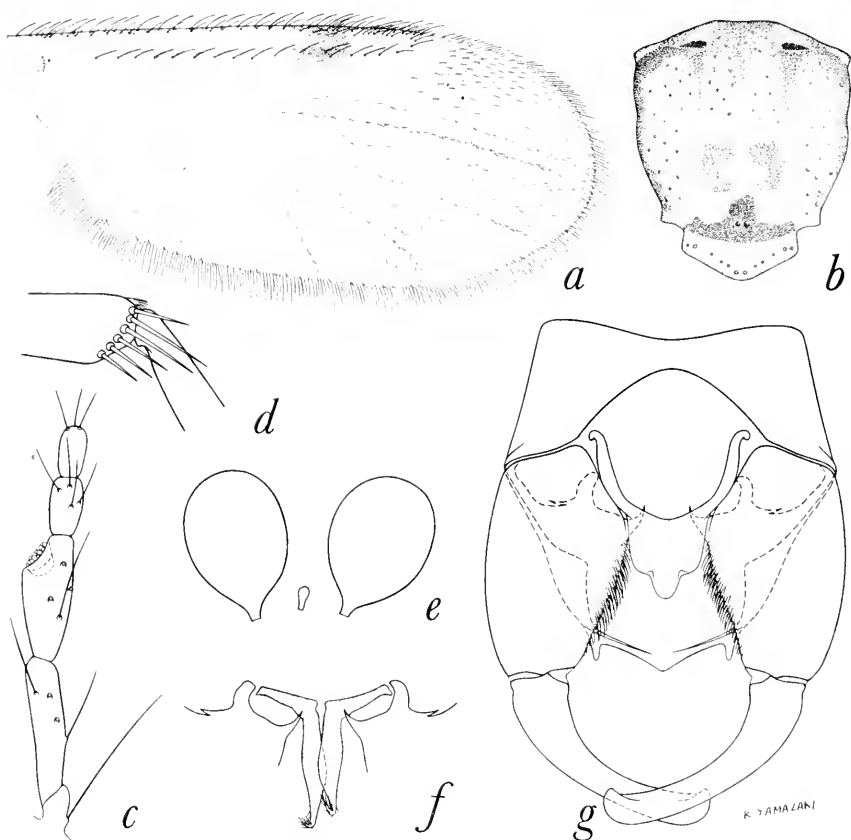


FIGURE 13.—*Culicoides elutus* Macfie. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

base abruptly bent laterad, nearly straight stem and hairy, ventrally bent apex.

DISTRIBUTION: Mexico; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CHIRIQUÍ PROVINCE: Boquete, Volcán.

PANAMÁ PROVINCE: Cerro Azul, Pacora.

DISCUSSION: This species is confined to the Chiriquí highlands and the adjacent jungle area at Almirante, country similar in ecology to the Chiapas highland area of Mexico from which it was originally described. Its closest Neotropical relative is *luteovenus* Root and Hoffman, a Nearctic species which follows the Central American highlands into Panama.

11. *Culicoides luteovenus* Root and Hoffman

FIGURE 14

Culicoides luteovenus Root and Hoffman, 1937, Amer. Journ. Hyg., vol. 25, p. 156 (male, female; San Jacinto, D. F., Mexico; fig. wing, male genitalia).—Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 76 (Chiapas, Mexico).—Wirth, 1952, Univ. California Publ. Ent., vol. 9, p. 175 (male, female; California, Washington, Utah; fig. wing, mesonotum, palpus); 1955, Proc. Ent. Soc. Washington, vol. 57, p. 110 (Guatemala).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 214 (male, female; Panama; fig. wing, mesonotum, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.35 (1.29–1.42, $n=4$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 22:18:18:19:20:20:20:21:25:26:28:32:41, antennal ratio 0.99 (0.95–1.03, $n=5$); distal sensory tufts present on segments

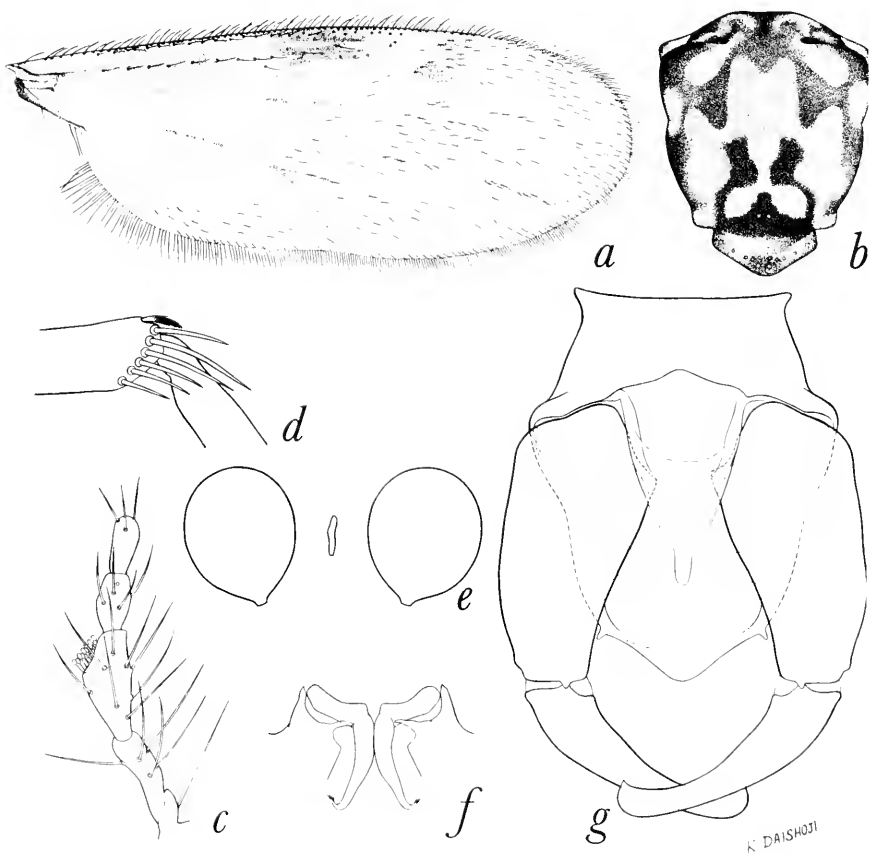


FIGURE 14.—*Culicoides luteovenus* Root and Hoffman. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

III, XI-XV. Palpal segments in proportion of 10:25:34:11:14; third segment slightly swollen, 2.45 (2.3-2.6, $n=2$) times as long as broad, with a broad, shallow, sensory pit. Mandible with 14 (13-17, $n=7$) teeth.

Thorax.—Mesonotum pruinose gray, with a prominent pattern of interconnected, subshining dark brown areas on anterior and lateral portions. Scutellum gray pruinose; postscutellum and pleuron shining dark brown. Legs dark brown, knees narrowly yellowish; base and apex of hind tibia with narrow pale rings; hind tibial comb with six spines, the second from the spur longest.

Wing.—Pattern as figured, the pale areas milky white to yellowish hyaline; distal pale spot in cell R_5 gradually evanescent towards wing tip. Macrotrichia numerous on distal half of wing, sparse in cell M_4 and in anal cell; costa extending to 0.60 of wing length. Halter yellowish.

Abdomen.—Blackish. Spermathecae two, pyriform, subequal, each measuring 0.061 by 0.045 mm.

MALE GENITALIA: Ninth sternum narrow, without caudomedian excavation; ninth tergum rounded caudally, with small apicolateral processes and a well-developed, undivided, caudomedian lobe with a distinct thickening on midline. Basistyle with well-developed dorsal and ventral roots, mesal margin with heavy spinose setae; dististyle with bluntly rounded apex. Aedeagus narrow, basal arch with faintly sclerotized membrane across distal half, apex slender and roundly pointed. Parameres separate, each with stout, abruptly bent base, stout and nearly straight stem and slender, bent, hairy tip.

DISTRIBUTION: Mexico; Guatemala; Panama; United States (California, Utah, Washington).

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Cerro Punta, Volcán.

DISCUSSION: *Culicoides luteovenus* is common in western North America, its range extending northward to Washington and southward along the Central American highlands into the Volcán region of Panama. In Guatemala it has been taken feeding on horses.

The *covagarciai* group

This group consists of large to medium-sized species with legs yellow or with knees broadly yellow-banded; mesonotum yellowish to brown, subshining; male genitalia like those of the *pulicaris* group, with basistyles mesally spinose, but with tendency for the development of long apicolateral processes and a caudomedian cleft on the ninth tergum, a basal sclerotized band and distal peg and spherical tip on

the aedeagus, together with a fusion of the parameres, all characters resembling those of the subgenus *Culicoides* (*Hoffmania*).

In systematic position and geographic development this group is intermediate between the subgenus *Culicoides* (*Hoffmania*) and the more typical *Culicoides* (*Culicoides*). When better investigated by further intensive collecting, the extraordinary speciation of this group and the *nigrigenus* group in Central America and the southern Caribbean fringe may shed important clues on the biogeographic history of the connections between North and South America.

PANAMA SPECIES: Five: *covagarciai* Ortiz, *efferus* Fox, *marshi* Wirth and Blanton, *metagonatus* Wirth and Blanton, and *rostratus* Wirth and Blanton.

12. *Culicoides efferus* Fox

FIGURE 15

Culicoides efferus Fox, 1952, Ann. Ent. Soc. Amer., vol. 45, p. 365 (female; Río Charape, Peru; fig. wing, palpus, tibial comb, spermathecae, antenna).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 217 (male, female; Peru, Panama, Nicaragua, Honduras; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.49 (1.35–1.62, $n=6$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 25:22:24:24:24:24:24:25:25:28:38:52, antennal ratio 0.93; distal sensory tufts present on segments III, XI–xv. Proboscis very long, 1.42 times as long as height of an eye. Palpal segments in proportion of 10:38:43:25:21, third segment slender, 3.9 (3.5–4.4, $n=6$) times as long as broad, with a small, shallow, sensory pit at distal third. Mandible with 24 (22–26, $n=8$) teeth.

Thorax.—Mesonotum and scutellum subshining bright yellow. Legs uniformly yellowish; hind tibial comb with six spines.

Wing.—Pattern as figured, pale yellowish, with very restricted dark spots; costa extending to 0.67 of wing length. Macrotrichia very scanty on distal fourth of wing. Halter whitish.

Abdomen.—Dark brown. Spermathecae two, pyriform, subequal, each measuring 0.053 by 0.041 mm.

MALE GENITALIA: Ninth sternum without posterior excavation; ninth tergum long and tapering, rounded caudad with only faint vestiges of apicolateral processes, deeply cleft mesad at apex with a pair of pointed, contiguous, bare, submedian lobes. Basistyle with ventral and dorsal roots undeveloped, mesal margin with yellowish hyaline spinose setae. Aedeagus narrow basally, anterior sclerotized membrane covering slightly more than distal half of basal arch; distal peg and apical spherical tip very slender. Parameres fused more than halfway to apices, the free portions very slender, pointed, hairy, the common basal portion not greatly expanded laterally.

DISTRIBUTION: Peru; Honduras; Nicaragua; Panama.

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Cerro Punta, Volcán.

DISCUSSION: The large size, yellow color, long proboscis, and slender, long third palpal segment with small round sensory pit will readily

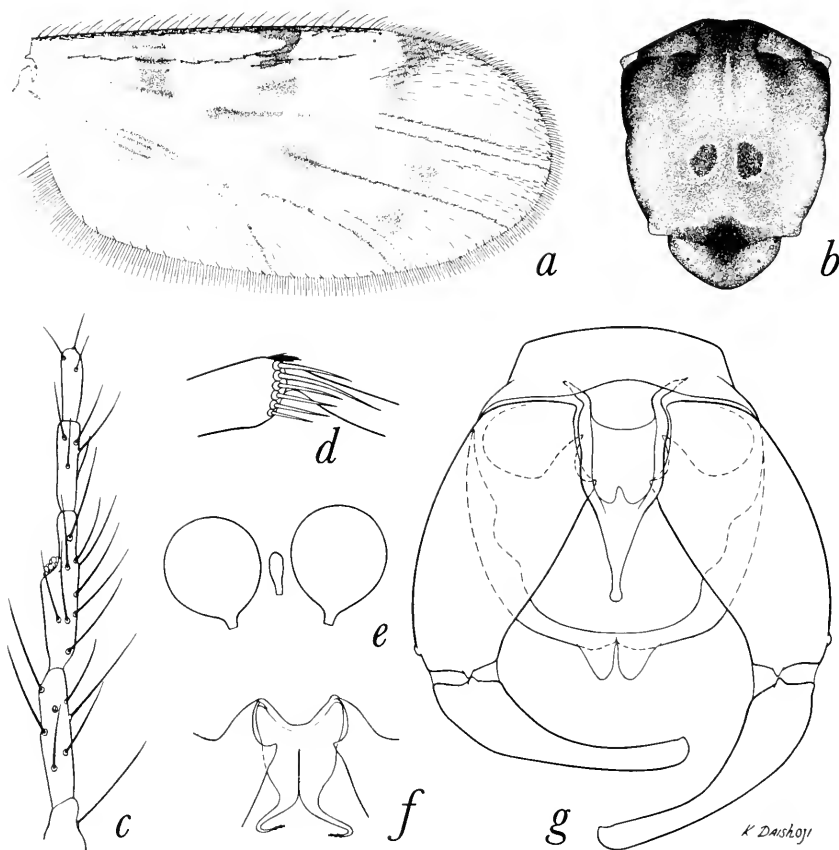


FIGURE 15.—*Culicoides efferus* Fox. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

distinguish this species. The caudally rounded tergum of the male genitalia is probably indicative of close relation to the species of the *pulicaris* group, but the long proboscis, brilliant yellow color, *Hoffmania*-like aedeagus and fused parameres are indicative of great evolutionary specialization.

13. *Culicoides rostratus* Wirth and Blanton

FIGURE 16

Culicoides rostratus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 219 (male, female; Panama; fig. wing, palpus, spermatheca, male genitalia).

FEMALE: Length of wing 1.13 (1.06–1.19, $n=9$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 25:17:17:19:19:19:19:24:24:26:32:45, antennal ratio 0.98; distal sensory tufts present on segments III, XI–XV. Proboscis elongate, its length to base of palpi about 1.2 times height of an eye. Palpal segments in proportion of 8:32:43:17:17, second segment long and fairly stout, third segment moderately swollen on proximal two-thirds, 2.6 (2.3–3.1, $n=8$) times as long as broad, with

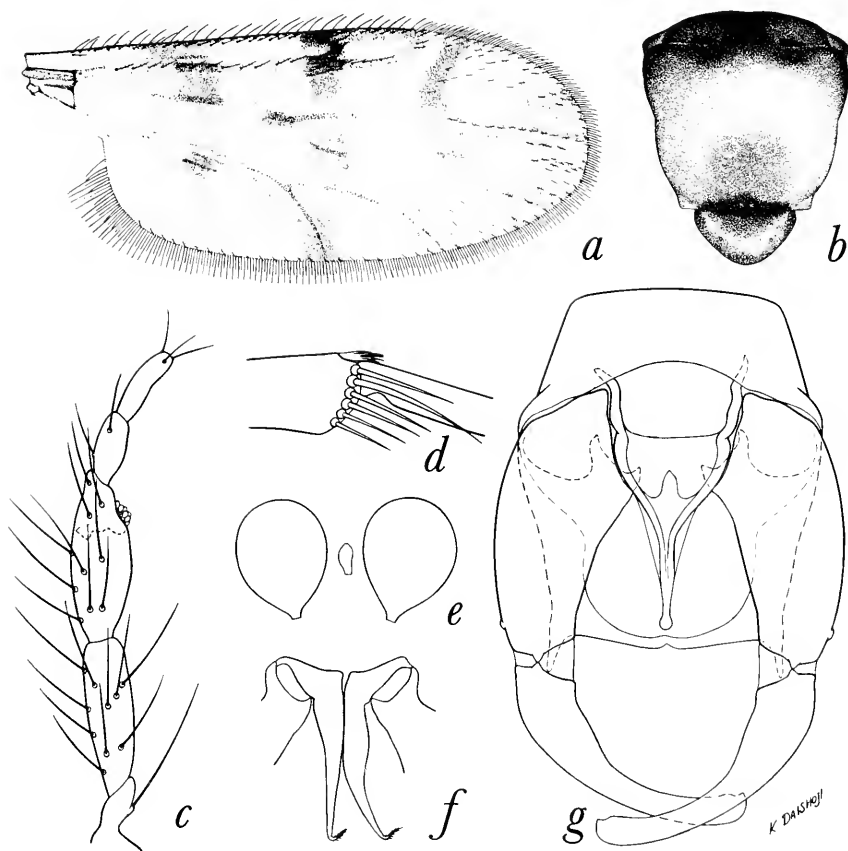


FIGURE 16.—*Culicoides rostratus* Wirth and Blanton. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

a hollowed, open, sensory area on the distal tapering portion. Mandible with 20 (19–21, $n=8$) teeth.

Thorax.—Mesonotum yellowish brown, becoming blackish at anterior margin. Scutellum concolorous with mesonotum; postscutellum and pleuron brown. Legs yellow, broad base of fore femur and apex of fore tibia brownish; hind tibial comb with six spines, the second from the spur longest.

Wing.—Pattern as figured, appearing pale yellowish with restricted dark spots and areas, pale spots in apices of cells R_5 and M_1 not meeting wing margin. Macrotrichia confined to a few in apices of cells R_5 , M_1 and M_2 ; costa extending to 0.68 of wing length. Halter yellowish white.

Abdomen.—Dark brown. Spermathecae two, pyriform, subequal, each measuring 0.058 by 0.043 mm.

MALE GENITALIA: Ninth sternum relatively broad, with broad caudomedian excavation extending about halfway to base; ninth tergum short and tapering, apex broad and truncated, with long, slender, apicolateral processes. Basistyle with ventral roots short and blunt, dorsal root longer and slenderer, mesal surface with small, spinose setae. Aedeagus broad at base, sclerotized membrane present between basal arms on distal half of arch, with indistinct anterior band; distal portion with long, slender, internal peg and slender, spherical tip. Parameres separate, each with abruptly bent, thickened base, slender, straight stem and gradually ventrally curved, pointed, hairy tip.

DISTRIBUTION: Panama.

PANAMA RECORDS:

COCLÉ PROVINCE: El Valle.

PANAMÁ PROVINCE: Cerro Campana (type locality).

DISCUSSION: This species closely resembles *efferus* Fox in its pale legs and wings, yellowish mesonotum, and long proboscis, but it is a smaller species and has the third palpal segment stouter without definite pit and the male genitalia are much different.

14. *Culicoides marshi* Wirth and Blanton

FIGURE 17.

Culicoides marshi Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 220 (female; Panama).

FEMALE: Length of wing 1.08 (1.06–1.12, $n=5$) mm.

Head.—Eyes bare, broadly contiguous. Antenna with flagellar segments in proportion of 30:21:22:22:22:22:22:25:25:31:33:50, antennal ratio 1.18; distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 10:31:40:16:13, third segment very slender, 3.5 (3.1–3.9, $n=2$) times as long as greatest breadth, with

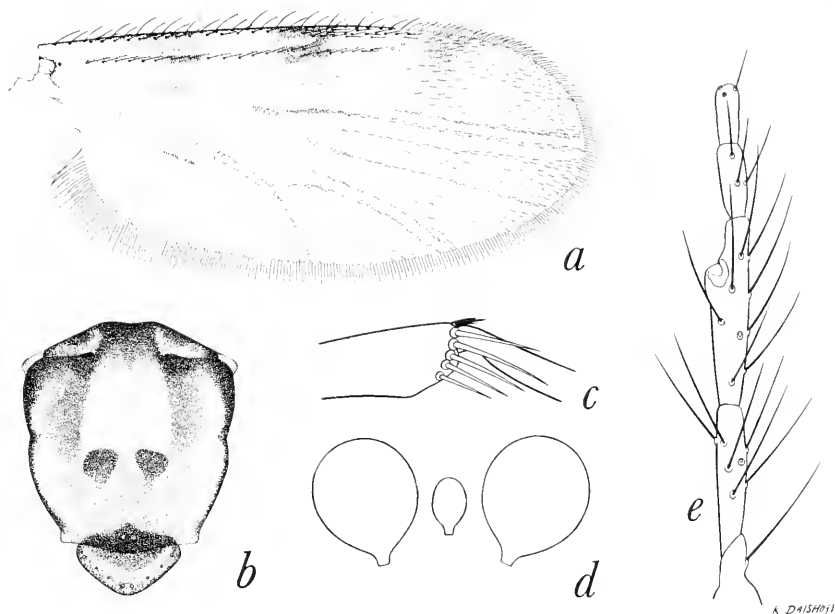


FIGURE 17.—*Culicoides marshi* Wirth and Blanton. Female: *a*, wing; *b*, thoracic pattern; *c*, tibial comb; *d*, spermathecae; *e*, palpus.

small, irregular, shallow, sensory pit. Mandible with 27 (26–28, $n=5$) teeth.

Thorax.—Mesonotum dark brown with a pruinose median area golden brown, anterior and lateral margins blackish. Scutellum, postscutellum and pleuron blackish brown. Legs dark brown, broad bands at knees on all femora and tibiae and apex of hind tibia yellowish; hind tibial comb with five (4–5, $n=4$) spines, the second from the spur longest.

Wing.—Pattern as figured, the distal pale spot in cell R_5 may or may not reach wing margin, distal pale spot in cell M_1 always separate from wing margin, the dark transverse bands of the pattern on distal half of wing irregular but connected, the pale spots rarely extensive enough to fuse in paler specimens. Macrotrichia fairly abundant on distal half of wing; costa extending to 0.68 of distance to wing tip. Halter yellowish.

Abdomen.—Blackish, cerci yellowish. Spermathecae two, slightly pyriform, subequal, each measuring 0.050 by 0.039 mm.

MALE: Unknown.

DISTRIBUTION: Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante (type locality).

DISCUSSION: This species resembles *covagarciai* in leg markings, but the length of proboscis allies it more closely with *rostratus*, while the palpi resemble those of *efferus*. The mandibles have more teeth and the antennal ratio is higher than in any of these three species.

15. *Culicoides covagarciai* Ortiz

FIGURE 18

Culicoides cova-garciai Ortiz, 1950, Rev. Sanid. Asist. Soc., vol. 15, p. 457 (male, female; Caracas, Venezuela; fig. wing, mesonotum, spermathecae, palpus, antenna).—Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 216 (male, female; Panama, Venezuela; synonym, *beebei* Fox; fig. wing, palpus, spermathecae, male genitalia).

Culicoides beebei Fox, 1952, Ann. Ent. Soc. Amer., vol. 45, p. 366 (female; Rancho Grande, Maracay, Venezuela; fig. wing, palpus, spermathecae, tibial comb).

FEMALE: Length of wing 1.19 (1.06–1.28, $n=10$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 20:15:16:16:16:16:16:20:21:25:28:38, antennal ratio 1.09; distal sensory tufts present on segments III, XI–XV. Proboscis from base of palpi to its tip 0.8 times as long as height of an eye. Palpal segments in proportion of 8:22:31:12:14, third segment swollen, 2.4 (2.1–2.7, $n=9$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 15 (15–16, $n=10$) teeth.

Thorax.—Mesonotum uniformly yellowish brown, varying from a golden yellow to a darker brown, scutellum somewhat darker. Legs brown, bases of femora, apices of fore and mid femora, bases of all tibiae, and apex of hind tibia broadly yellowish; hind tibial comb with six spines.

Wing.—Pattern as figured, all of second radial cell except extreme base in a yellow area, wing predominantly pale marked, with irregular, broken, transverse dark bands. Macrotrichia very sparse on distal fourth of wing; costa extending 0.67 way to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, slightly ovoid, subequal, each measuring 0.050 by 0.043 mm.

MALE GENITALIA: Ninth sternum with moderately deep caudo-median excavation; ninth tergum with truncated caudal margin bearing long, slender, apicolateral processes. Basistyle with ventral root short and blunt, dorsal root longer and slender, heavy spinose setae present on mesal surface. Aedeagus long, narrow at base, a sclerotized transverse membrane near base of arch, a distinct internal peg-like sclerotization at base of distal stem, latter with spherical tip. Parameres separated at bases, each with abruptly bent stout basal portion; straight tapering stem and pointed, slender, hairy tip.

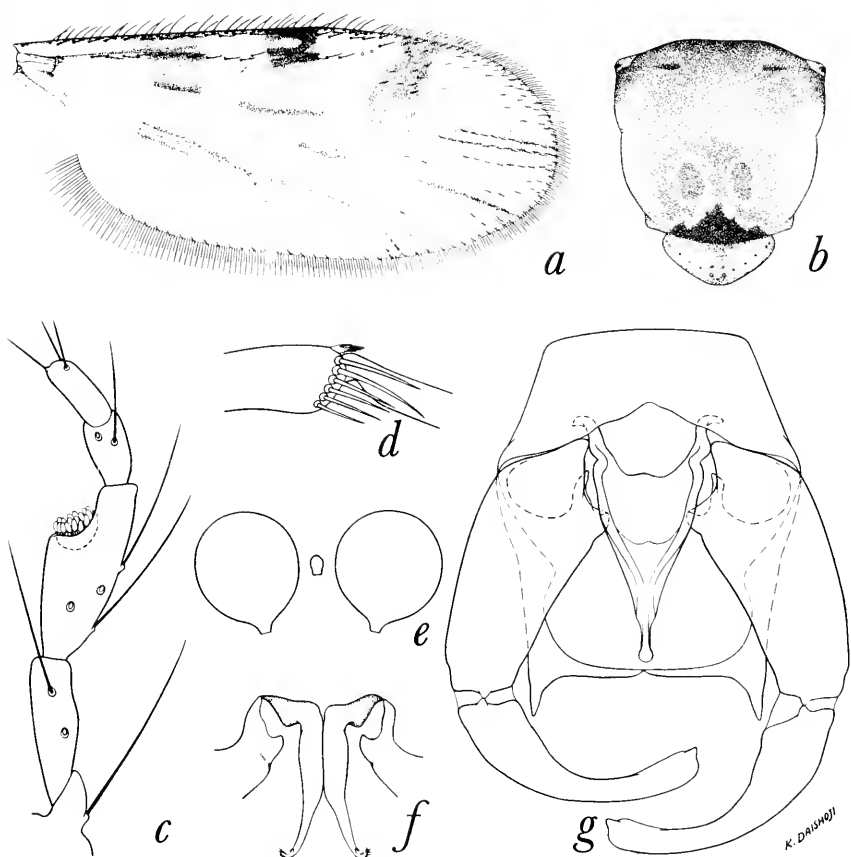


FIGURE 18.—*Culicoides covagarciai* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

DISTRIBUTION: Venezuela; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CHIRIQUÍ PROVINCE: Boquete, Cerro Punta, Volcán.

COCLÉ PROVINCE: El Valle.

PANAMÁ PROVINCE: Cerro Campana.

DISCUSSION: This species is easily recognized by its dark wings with well-isolated pale areas, its dark brown legs with broadly pale knees, the short proboscis and swollen third palpal segment with broad sensory pit.

16. *Culicoides metagonatus* Wirth and Blanton

FIGURE 19

Culicoides metagonatus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 221 (male, female; Panama; fig. wing, palpus, spermatheca, male genitalia).

FEMALE: Length of wing 1.02 (0.89–1.19, $n=12$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 25:20:20:20:20:20:20:20:25:25:28:30:48, antennal ratio 0.95; distal sensory tufts present on segments III, XI–xv. Palpal segments in proportion of 8:17:26:11:15, third segment swollen, 2.1 (1.9–2.5, $n=9$) times as long as greatest breadth, without sensory pit, the sensoria scattered over mesal surface of segment. Mandible with 15 (14–16, $n=8$) teeth.

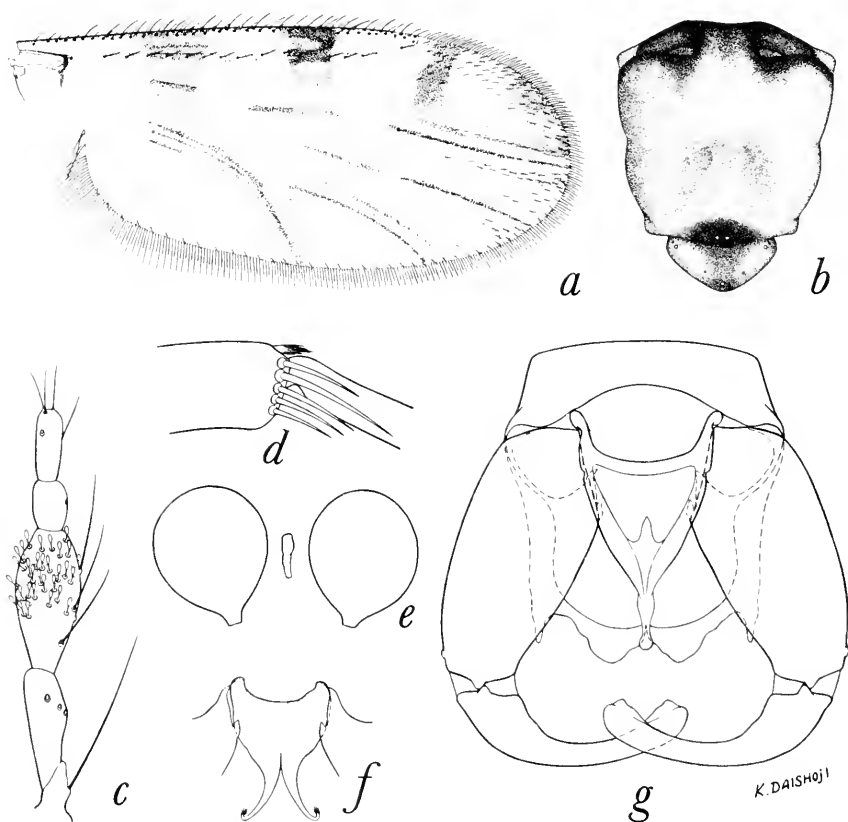


FIGURE 19.—*Culicoides metagonatus* Wirth and Blanton. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia parameres removed.

Thorax.—Mesonotum subshining, yellowish brown, darker brown to blackish on anterior margin, humeri and sensory pits whitish pruinose, a small blackish spot present medially just anterior to scutellum. Scutellum, postscutellum and pleura yellowish brown. Legs yellow, hind knee with a black spot; hind tibial comb with six spines, the second from the spur longest.

Wing.—Pattern as figured, the pale areas predominant. Macrotrichia sparse in apices of cells R_5 , M_1 and M_2 ; costa extending to 0.63 of wing length. Halter yellowish white.

Abdomen.—Brownish black; terga with narrow, whitish, apical bands. Spermathecae two, pyriform, subequal, measuring 0.048 by 0.039 mm.

MALE GENITALIA: Ninth sternum very narrow, with a very shallow caudomedian excavation; ninth tergum short and tapering, apicolateral process very small, caudal margin between them cleft and bilobate, with a submedian pair of hyaline, bare, rounded lobes produced caudad. Basistyle with ventral and dorsal roots poorly developed, mesal margin with fine spinose setae. Aedeagus with broad base, basal arms stout, a sclerotized anterior band at one-fourth distance to apex, the apex slender with a spherical tip and internal peg. Parameres fused for a third of total length, the fused bases without winglike or lateral expansions, the basal margin concave, the free portions very slender and tapering to fine, minutely hairy tips.

DISTRIBUTION: Panama; Nicaragua.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CHIRIQUÍ PROVINCE: Cerro Punta, Volcán.

COCLÉ PROVINCE: El Retiro, El Valle, Penonomé.

DARIEN PROVINCE: Jaqué.

PANAMÁ PROVINCE: Cerro Campana (type locality).

DISCUSSION: Related to *covagarciai* in wing and mesonotal pattern, the short proboscis and unmodified antenna, but unique in having the third palpal segment swollen without sensory pit, only hind knee black, and the male genitalia with mesally cleft, bilobate tergum and fused parameres.

The *nigrigenus* group

This group consists of large species with knees black-spotted and legs mostly yellowish; mesonotum dull grayish to brownish; palpus with a large, deep, sensory pit; male genitalia with basistyle mesally spinose, apicolateral processes well developed, aedeagus without basal barlike sclerotization or ball-like tip, parameres separate with well-developed basal knob. Differs from the *covagarciai* group by having moniliform proximal antennal segments (antennal ratio,

1.3–2.1), sensoria present on segments III–XV or III, VIII–XV, and only four tibial spines.

This group is intermediate between typical *Culicoides* (*Culicoides*) and the *daedalus* group of the subgenus *Culicoides* (*Oecacta*). *Culicoides decor* (Williston), known only from the island of St. Vincent in the West Indies, belongs to this group (see remarks under *nigrigenus*). There are three Panama species—*chrysonotus* Wirth and Blanton, *lutealaris* Wirth and Blanton, and *nigrigenus* Wirth and Blanton.

17. *Culicoides nigrigenus* Wirth and Blanton

FIGURE 20

Culicoides nigrigenus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol 58, p. 222 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.11 (1.02–1.25, $n=8$) mm.

Head.—Eyes bare, contiguous. Antenna with flagellar segments in proportion of 20:15:15:15:15:15:15:15:47:50:50:50:55, antennal ratio 2.0; distal sensory tufts present on segments III–XV. Palpal segments in proportion of 10:20:30:10:10, third segment greatly swollen, 1.9 (1.7–2.1, $n=6$) times as long as greatest breadth, with a broad, deep sensory pit. Mandible with 13 (10–15, $n=10$) teeth.

Thorax.—Mesonotum yellowish brown, with grayish pruinosity becoming very prominent in some specimens, anterior margin narrowly dark brown, dark brown spot present just anterior to scutellum. Scutellum concolorous with mesonotum, postscutellum and pleuron dark brown. Legs yellow, fore and mid femora pale brown on basal halves, hind femur with broad median brown band and distal two-thirds of fore tibia brownish; prominent knee spot on all legs and the narrow apex of hind tibia blackish; hind tibial comb with four spines, the one nearest the spur longest.

Wing.—Pattern as figured, with pale markings predominant, the dark markings rarely extensive enough on distal half of wing to be interconnected. Macrotrichia very numerous on distal half of wing and extending to near base in anal cell and cell M_2 ; costa extending to 0.64 of distance to wing tip. Halter yellowish white.

Abdomen.—Brownish, the terga whitish. Spermathecae two, pyriform, subequal, each measuring 0.057 by 0.044 mm.

MALE GENITALIA: Ninth sternum narrow, with a broad, shallow, caudomedian excavation; ninth tergum with large, triangular, apicolateral processes, the caudal margin between them truncated, with a slight mesal notch. Basistyle with ventral and dorsal roots small and simple, no spinose setae on mesal surface. Aedeagus V-shaped, without anterior transverse marginal band or distal peglike internal sclerotization, apex slender and rounded but not spherical. Para-

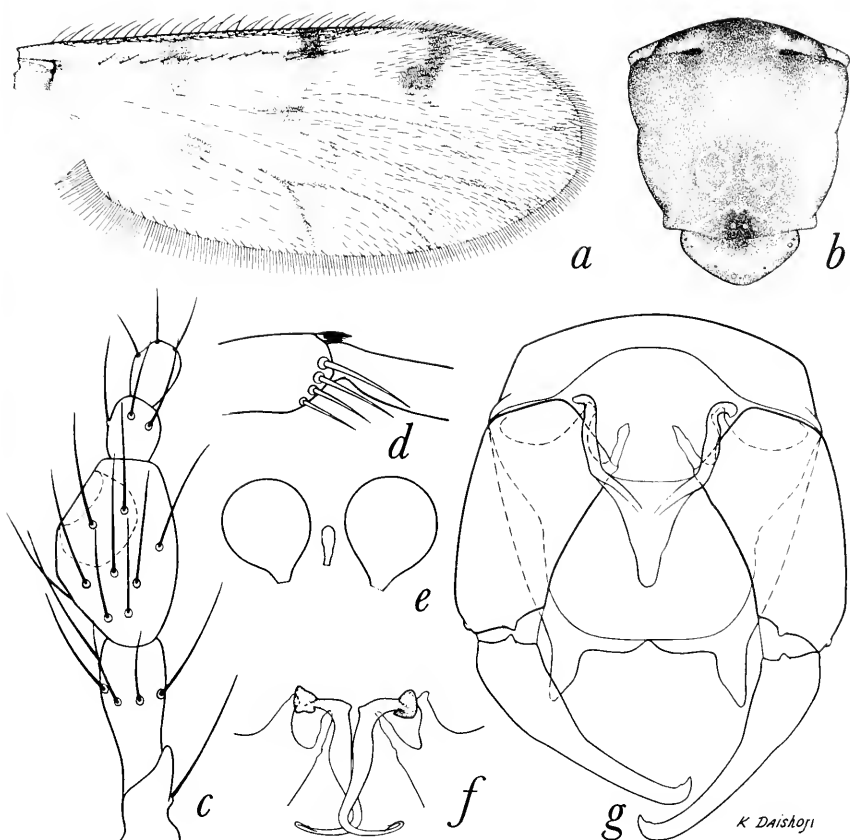


FIGURE 20.—*Culicoides nigrigenus* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

meres separate, each with abruptly bent, knobbed base, nearly straight, slender stem and slender pointed apex abruptly bent laterad, thence ventromesad.

DISTRIBUTION: Panama; Honduras, Nicaragua.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante (type locality).

PANAMÁ PROVINCE: Cerro Campana.

DISCUSSION.—This species is similar to *Culicoides decor* (Williston), which is known only from the type female from the island of St. Vincent. According to notes on the type made by the senior author at the British Museum (Natural History) in July 1957, *decor* differs from *nigrigenus* in having the pale wing markings more restricted, in the form of discrete rounded spots which are smaller than in the darkest

individuals of *nigrigenus*, and in the leg markings, with broad pale bands on each side of the knees. According to Williston's original description, *decor* also differs in having the abdominal terga blackish with pale segmental bands of integumental coloring.

Two Panama species, *chrysonotus* Wirth and Blanton and *lutealaris* Wirth and Blanton, also have all the knees black, but these species are larger and have darker, less hairy wings and the femora blackish at the bases.

18. *Culicoides lutealaris* Wirth and Blanton

FIGURE 21

Culicoides lutealaris Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 225 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.56 (1.49–1.62, $n=7$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 20:18:18:18:18:18:19:38:38:38:42:60, antennal ratio 1.3; distal sensory tufts present on segments III–xv. Palpal segments in proportion of 10:30:55:16:14, third segment greatly swollen, 1.9 (1.7–2.1, $n=7$) times as long as greatest breadth, with an extremely large sensory cavity opening through a large pore. Mandible with 14 teeth.

Thorax.—Mesonotum dark brown, with dense, rather dark, yellowish gray pollen; area around humeral pits and narrow lateral lines blackish. Scutellum pollinose dark brown; pleuron brown, paler above. Legs yellowish, knee spots black; femora with broad blackish bands extending from near extreme bases two-thirds of distance to apices, fore tibia brownish except at extreme base, mid and hind tibiae with fainter infuscation on distal halves, narrow apex of hind tibia blackish; hind tibial comb with four spines, the one nearest the spur longest.

Wing.—Pattern as figured, distal pale spot in cell M_1 broadly meeting wing margin. Macrotrichia abundant, extending nearly to base of anal cell; costa extending to 0.58 (0.57–0.62, $n=7$) of distance to wing tip. Halter yellowish.

Abdomen.—Dark brown, terga with indistinct sublateral blackish areas; distal apical integumental bands and faint pollen on entire dorsum whitish, cerci yellowish. Spermathecae two, pyriform, subequal, each measuring 0.060 by 0.048 mm.

MALE GENITALIA: Ninth sternum narrow, with a broad, shallow, caudomedian excavation; ninth tergum with long, pointed, apicolateral processes, the caudal margin between them distinctly notched medially. Basistyle with ventral and dorsal roots long and slender; mesal margin without spinose setae. Aedeagus with heavily sclero-

tized basal arms forming a narrow basal arch, anterior sclerotized membrane absent; distal stem tapering to a very slender, pointed apex. Parameres separate, each with bent, knobbed base, slightly sinuate, slender stem and very slender, recurved, simple, pointed apex.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Volcán (type locality).

DISCUSSION: This species resembles *chrysonotus* Wirth and Blanton in leg and mesonotal markings and general wing pattern, but differs from *chrysonotus* and resembles *nigrigenus* in having a greatly swollen third palpal segment, sensoria on all proximal antennal flagellar segments, and more extensive pale wing markings, although markings are never so extensive as in *nigrigenus*.

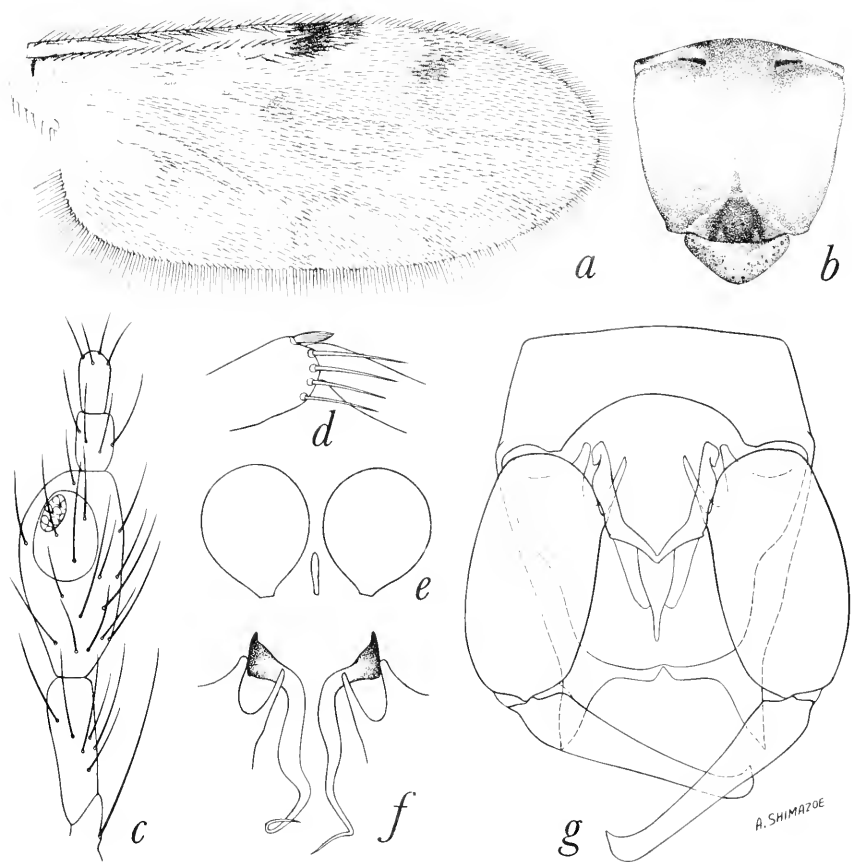


FIGURE 21.—*Culicoides lutealaris* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

19. *Culicoides chrysonotus* Wirth and Blanton

FIGURE 22

Culicoides chrysonotus Wirth and Blanton, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 226 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.66 (1.58–1.75, $n=7$) mm.

Head—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 20:15:15:15:15:16:16:17:48:48:50:50:72, antennal ratio 2.1; sensoria present on segments III, VIII–XV. Palpal segments in

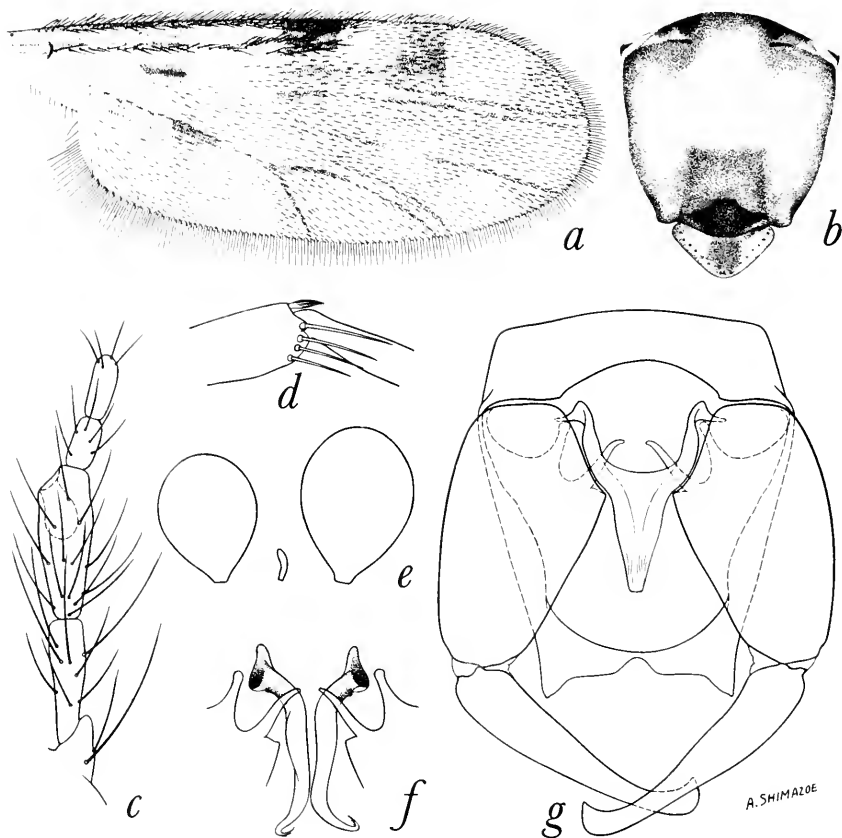


FIGURE 22.—*Culicoides chrysonotus* Wirth and Blanton. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

proportion of 15:35:50:20:20, third segment moderately swollen, 1.91 times as long as greatest breadth, sensory pit deep, with broad opening near apex of segment. Mandible with 14 (13-14, $n=6$) teeth.

Thorax—Mesonotum dark brown with dense golden brown pollen, anterolateral corners broadly blackish. Scutellum dark brown, pleuron blackish. Legs yellowish, narrow knee spots black; femora with broad blackish bands extending from near extreme bases to two-thirds of distance to apices, fore tibia brownish except at extreme base, mid and hind tibiae with fainter infuscation on distal halves, narrow apex of hind tibia blackish; hind tibial comb with four spines, the one nearest the spur longest.

Wing—Pattern as figured, appearing dark with large, more or less isolated, rounded yellow spots, pale spot straddling vein M_1 separated from pale spot at end of second radial cell by a narrow dark area, distal pale spot in cell M_1 not attaining wing margin. Macrotrichia abundant, extending nearly to base of anal cell, costa extending to 0.60 of wing length. Halter pale yellowish.

Abdomen—Blackish, cerci yellowish. Spermathecae two, pyriform, subequal, each measuring 0.072 by 0.052 mm.

MALE GENITALIA: Ninth sternum narrow, with broad, shallow, caudomedian excavation; ninth tergum with short, bluntly pointed, apicolateral processes, the caudal margin between them slightly notched medially. Basistyle with ventral and dorsal roots each long and slender, mesal surface without spinose setae. Aedeagus with heavily sclerotized basal arms, a faintly sclerotized anterior membrane forming a rounded basal arch, distal stem stout and tapering slightly to a bluntly rounded apex. Parameres separate, each with bent, knobbed base, nearly straight, slender stem and slender, recurved, simple pointed apex.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Volcán (type locality).

DISCUSSION: The more typical, only moderately swollen, third palpal segment will separate *chrysonotus* from the other three species of this group with black knees, *lutealaris* Wirth and Blanton, *nigri-genus* Wirth and Blanton and *decor* (Williston). In size, mesonotal and leg color, and general appearance it is most clearly related to *lutealaris*, but that species has more extensive pale wing markings, with the distal pale spot in cell M_1 extending to the wing margin and the pale spot at the end of the second radial cell not separated from the pale spot straddling vein M_1 .

Subgenus *Culicoides* (*Oecacta*) Poey

Oecacta Poey, 1851, Mem. Hist. Nat. Isla Cuba, vol. 1, p. 236. (Type: *Oecacta furens* Poey, monobasic.)

Psychophaena Philippi, 1865, Verh. Zool.-Bot. Ges. Wien, vol. 15, p. 628.—Wirth, 1955, Rev. Chilena Ent., vol. 4, p. 234. (Type: *Culicoides venezuelensis* Ortiz, as *Psychophaena pictipennis* Philippi, monobasic.)

Haematomyidium Goeldi, 1905, Mem. Mus. Goeldi, vol. 4, p. 137. (Type: *Haematomyidium paraense* Goeldi, monobasic.)

Species with the second radial cell usually entirely dark; wing usually with prominent pattern; male parameres separate; basistyle with well-developed, foot-shaped or pointed, ventral root; ninth tergum with well developed apicolateral processes; spermathecae usually two, rarely one; hind tibial comb with four (rarely five or seven) spines.

This subgenus has undergone a tremendous development in the Neotropical region, with the evolution of numerous groups of related species. Groups of this subgenus found in Panama are *daedalus*, *copiosus* (p. 332), *iriartei* (p. 342), *scopus* (p. 347), *limai* (p. 349), *acotylus* (p. 362), *reticulatus* (p. 376), *furens* (p. 397), *fluvialis* (p. 407), *transferrans* (p. 420), *leoni* (p. 426), *debilipalpis* (p. 431), *pachymerus* (p. 454), *arubae* (p. 464), and *stigmalis* (p. 466).

The *daedalus* group

This group consists of medium-sized species with very hairy wing; male genitalia with ventral root of basistyle slender, short and pointed, paramere with the base not directed laterad, with a long anterior process on the basal knob and with simple twisted tip and aedeagus simple, V-shaped or Y-shaped and slender at the apex; wing with a pale spot present straddling vein M_2 , a pale spot lying adjacent to the anterior side of vein M_1 only in *crescentis*; female antenna with sensoria present on segments III, XI–XV or on III, V, VII, IX, and XI–XV; female palpal pit broad and shallow or deep and opening by a small pore.

PANAMA SPECIES:

The species of this group are most numerous in western Panama at Almirante or in the Upper Tropical Zone at Cerro Campana and El Valle, only a few species ranging to the Canal Zone. There are seven or eight Panama species: *antefurcatus*, new species; *commatis*, new species; *crescentis*, new species; *daedalus* Macfie; *dunni*, new species; *pampoikilus* Macfie, and *phaeonotus*, new species. *Culicoides daedaloides*, new species, is provisionally referred here but its position is uncertain.

20. *Culicoides antefurcatus*, new species

FIGURE 23

FEMALE: Length of wing 0.79 ($n=2$) mm.

Head—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 14:13:13:14:15:15:15:16:22:22:27:28:34, antennal ratio 1.16 ($n=2$); distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 9:21:26:6:7, third segment only slightly swollen, 2.0 (1.9–2.2, $n=2$) times as long as greatest breadth, with a broad, shallow sensory pit. Mandible with 14 ($n=2$) teeth.

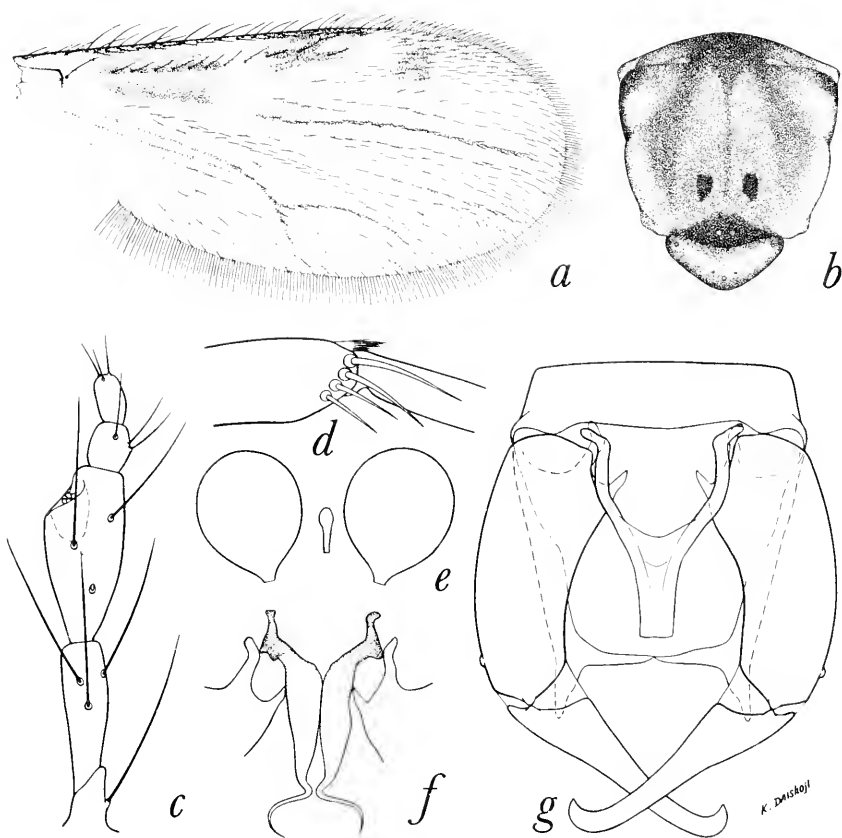


FIGURE 23.—*Culicoides antefurcatus*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum pruinose yellowish gray, with a brown pattern consisting of a very fine median line from anterior margin to scutellum and a pair of sublateral longitudinal bands. Scutellum brown; post-scutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with 4–5 ($n=2$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, second radial cell only moderately dark; pale spot over r-m crossvein large, broadly meeting costal margin; poststigmatic pale spot in cell R_5 double and oblique, the posterior part slightly larger; distal pale spot in cell R_5 elongate longitudinally, filling apex of cell R_5 ; pale spot present straddling middle of vein M_2 ; distal pale spots in cell M_1 and cell M_2 broadly meeting wing margin; pale spot in cell M_4 large and rounded, nearly filling cell; a large double spot in distal part of anal cell broadly reaching posterior wing margin, base of anal cell with large pale area; cell M_2 at base with a linear streak which extends to the pale spot straddling middle of vein M_2 , a pale spot present lying in front of mediocubital fork. Macrotrichia sparse but well distributed, extending nearly to bases of cell M_2 and anal cell; costa extending to 0.58 ($n=2$) of distance to wing tip. Halter yellowish.

Abdomen.—Dark brown, proximal terga pale. Spermathecae two, subequal, pyriform, bases of the ducts not sclerotized, collapsed and not measured in available specimens.

MALE GENITALIA: Ninth sternum without apparent caudomedian excavation; ninth tergum with long, pointed, apicolateral processes. Basistyle with ventral root very fine-pointed, dorsal root longer and slender; dististyle with bent, slender, pointed apex. Aedeagus with basal arch extending to nearly half of total length, the basal arms stout and nearly straight; distal portion stout and tapered to broad, truncated tip. Parameres each with very small basal knob bearing a slender anterior process, stem slender at base, mid portion swollen basally, then gradually tapered to abruptly bent, slender, simple point.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63158), allotype male, Almirante, Bocas del Toro Province, Panama, November 1952, F. S. Blanton, light trap. Paratypes, 2 males, 4 females: 4 females, Almirante, December 1952 to March 1953; 1 male, Mojinga Swamp, Canal Zone, Oct. 24, 1951; 1 male, Cerro Campana, Panamá Province, September 1952.

DISCUSSION: This species superficially resembles *tenuilobus*, new species, in general facies and wing markings, both having a large apical pale spot in cell R_5 , a pale spot at wing margin in cell M_1 and a pale spot straddling vein M_2 , but *tenuilobus* belongs to the *limai*

group near *galindoi* on the basis of antennal sensorial pattern and male genitalic structure, on external characters it can readily be distinguished from *antefurcatus* by its subapical pale rings on the hind femur, swollen third palpal segment, only one pale spot in the distal portion of the anal cell and no pale spot in cell M_2 in front of the mediocubital fork.

21. *Culicoides crescentis*, new species

FIGURE 24

FEMALE: Length of wing 0.95 (0.86–1.02, $n=8$) mm.

Head.—Eyes narrowly separated, bare. Antenna with segments in proportion of 17:10:11:10:11:10:10:11:23:23:25:26:36, antennal ratio 1.48; distal sensory tufts present on segments III, XI–XV. Palpal

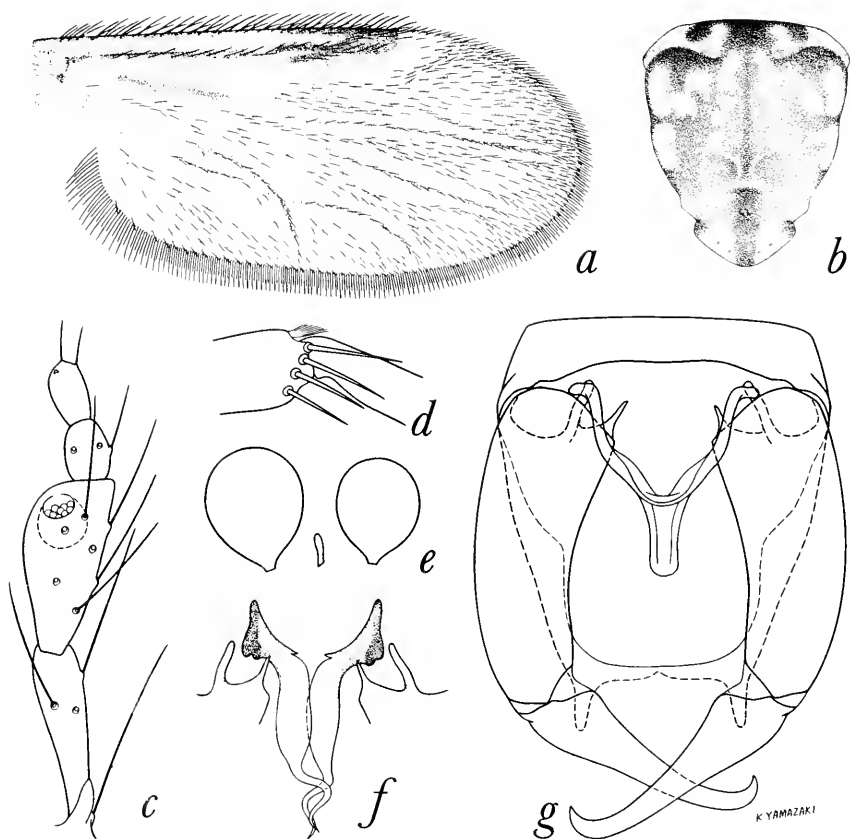


FIGURE 24.—*Culicoides crescentis*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

segments in proportion of 10:18:25:9:9, third segment moderately swollen, 1.8 (1.5–2.0, $n=8$) times as long as greatest breadth, with a large, deep sensory pit opening by a small distal pore. Mandible with 13 (12–14, $n=8$) teeth.

Thorax.—Mesonotum yellowish brown, with prominent pattern of dark brown patches as figured, consisting principally of a broad median anterior band and two lateral posterior bands associated with numerous, more or less interconnected, smaller dark brown dots. Scutellum yellowish brown, narrowly dark brown in middle and on extreme sides; postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four (4–5, $n=7$) spines, the two nearest the spur longest, subequal.

Wing.—Pattern as figured, small pale spot present over basal areculus and over r-m crossvein, the latter indistinctly continued broadly to costal wing margin; poststigmatic pale spot in cell R_5 double, the posterior portion located behind second radial cell; distal pale spot in cell R_5 crescent-shaped, concave distally, not meeting wing margin; a small, elongate pale spot present in cell R_5 lying just in front of vein M_1 between the two anterior spots; apices of veins M_1 , M_2 and M_{3+4} with pale spot at wing margin; small pale spot in cell M_1 far removed from wing margin; pale spot present straddling middle of vein M_2 ; pale spot in apex of cell M_2 at wing margin; an hour-glass-shaped pale spot in cell M_4 with linear extension along vein M_{3+4} to base of cell M_4 ; two separate pale spots in distal part of anal cell and two pale areas at base of cell; pale spot behind medial fork, one in front of mediocubital fork, and one in front of midportion of stem of mediocubitus. Macrotrichia numerous and long, extending to base of cell M_2 and anal cell; costa extending to 0.62 (0.61–0.65, $n=8$) of distance to wing tip. Halter pale, the base of the knob dark.

Abdomen.—Brownish black. Spermathecae two, subequal, slightly ovoid, each measuring 0.045 by 0.037 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum long and tapering with small caudomedian notch and large, rather slender, apicolateral processes. Basistyle with ventral root small and pointed, dorsal root slender; dististyle with very slender, markedly bent, pointed apex. Aedeagus with basal arch extending to about two-thirds of total length of aedeagus, notched caudomesad, with basal arms distinctly curved; distal apex slender and simple with rounded tip. Parameres each with basal knob bearing a long anterior projection; stem slender and bent at base, midportion moderately swollen, straight; distal portion abruptly narrowed to slender, simple, filiform tip with a corkscrew twist.

DISTRIBUTION: Panama; Mexico, Nicaragua.

SPECIMENS EXAMINED: Holotype female, Mojinga Swamp, Canal Zone, Dec. 11, 1951, F. S. Blanton, light trap (USNM 63159). Allotype male, Las Palmas, Veraguas Province, July 1953, F. S. Blanton. Paratypes, 2 males, 23 females: PANAMA: 7 females, Mojinga Swamp, Canal Zone, Aug. 28, Oct. 24, 1951, May 7, 1952; 1 male, 1 female, Loma Boracho, Canal Zone, Oct. 23, 1951, July 1952; 6 females, Almirante, Bocas del Toro Province, November 1952 to January 1953; 1 female, El Valle, Coclé Province, Dec. 22, 1953; 1 male, Río Hato, Coclé Province, Aug. 3, 1952; 1 female, Piña, Colón Province, Jan. 18, 1954; 1 female, Punta Patiño, Darién Province, July 1952; 3 females, Isla Taboga, Panamá Province, Dec. 10, 11, 1953; 1 female, Las Palmas, Veraguas Province, July 1953. MEXICO: 1 female, Tapachula, Chiapas, Sept. 20, 1944; B. Brookman, light trap. NICARAGUA: 1 female, Villa Somoza, July 14, 1953, P. Galindo, light trap.

DISCUSSION: This species has a wing pattern similar to that of *iriartei* Fox, but can be distinguished by the crescent-shaped distal pale spot in cell R_5 of the wing, by the presence of only one small pale spot bordering vein M_1 , two pale spots in the distal portion of the anal cell, by the brown mottlings in addition to the large patches in the mesonotal pattern, and by the different arrangement of antennal sensoria. The sensorial distribution and the characters of the male genitalia of *crescentis* indicate that this species is closely related to *daedalus* Macfie and *antefurcatus*, new species, in the *daedalus* group.

22. *Culicoides daedalus* Macfie

FIGURE 25

Culicoides daedalus Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 83 (male; Chiapas, Mexico; fig. wing, genitalia).—Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 277 (male; Venezuela; fig. wing, palpus, antenna, genitalia).

Culicoides sp., Ortiz, 1951, Rev. Sanid. Asist. Soc., vol. 16, p. 583 (female; Venezuela; fig. wing, palpus, antenna, spermathecae).

FEMALE: Length of wing 1.01 (0.92–1.09, $n=5$) mm.

Head—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 20:17:15:14:15:14:14:15:31:32:32:35:45, antennal ratio 1.34 (1.30–1.41, $n=3$); distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 12:25:30:11:9, third segment moderately swollen, 2.0 (1.9–2.1, $n=6$) times as long as greatest breadth, with a large, deep, sensory pit opening by a slightly smaller pore. Mandible with 13 (12–13, $n=5$) teeth.

Thorax.—Mesonotum pruinose gray with a prominent, reticulated pattern of blackish brown patches consisting of a narrow median anterior band, a pair of sublateral bands and irregular marks near

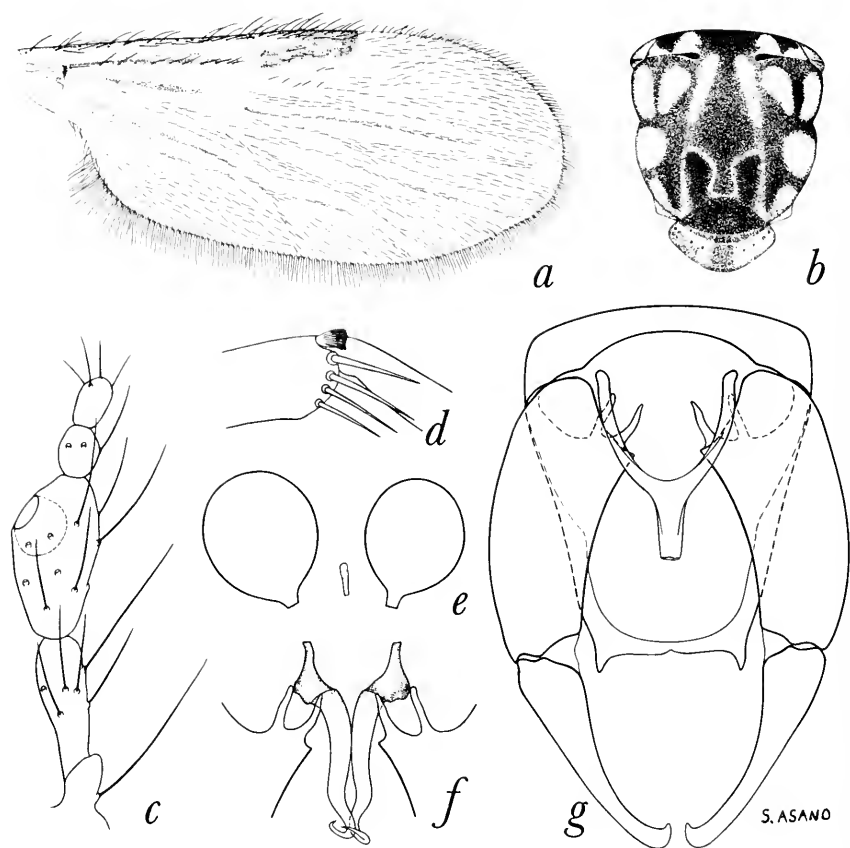


FIGURE 25.—*Culicoides daedalus* Macfie. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

humeral pits and lateral margins. Scutellum narrowly dark brown in middle, yellowish on sides; postscutellum and pleuron blackish brown. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal, narrow pale rings, subapical rings on hind femur and apex of hind tibia very obscurely pale; hind tibial comb with four ($n=5$) spines, the two nearest the spur longest.

Wing.—Pattern as figured, second radial cell very dark; pale spot over r-m crossvein broadly continued to costal margin; poststigmatic pale spot in cell R_5 double. the posterior part only slightly displaced proximad; distal pale spot in cell R_5 quadrate, not reaching anterior wing margin; pale spot in cell M_1 lying far removed from wing margin; pale spot present straddling middle of vein M_2 ; distal pale spot in cell M_2 round and lying adjacent to wing margin; pale spot in cell M_4 ex-

tending its full breadth from wing margin to posterior side of vein M_{3+4} ; two well separated round pale spots in distal part of anal cell and a third near hind wing margin at base of cell; cell M_2 with small pale spot lying in front of mediocubital fork and one lying behind medial fork; pale spot present straddling middle of stem of medio-cubitus. Macrotrichia long and numerous, extending to base of wing in cell M_2 and anal cell; costa extending to 0.62 (0.59–0.64, $n=5$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, slightly unequal; pyriform, measuring 0.058 by 0.046 and 0.050 by 0.038 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with very shallow, broad, caudomedian excavation; ninth tergum tapering with large, triangular, apicolateral processes. Basistyle with very small, pointed, ventral root; dorsal root longer and slender; dististyle slender and slightly curved, with bent, pointed tip. Aedeagus with basal arch extending to about three-fourths of total length of aedeagus, the basal arms slender and nearly straight; distal portion short and slender with simple tip. Parameres each with large basal knob bearing a long anterior process; stem slender and gently curved at base, nearly straight and slightly swollen in midportion, distal portion gradually narrowed to slender twisted tip.

DISTRIBUTION: Mexico; Venezuela; Panama; Honduras (Lancetilla).

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

DISCUSSION: This species is closely related to *crescentis*, new species, and *antefurcatus*, new species, but can easily be separated from the first by the lack of the small pale spot lying in front of vein M_1 and from the second by the location of the distal pale spot in cell M_1 far from the wing margin. The wing pattern of *daedalus* is closest to that of *daedaloides*, but in *daedaloides* the distal pale spots in the anal cell are fused, there is a subapical pale ring on the hind femur and the wing is only sparsely hairy.

23. *Culicoides commatis*, new species

FIGURE 26

FEMALE: Length of wing 1.02 mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:12:14:13:15:14:14:15:28:27:29:29:42, antennal ratio 1.19; distal sensory tufts present on segments III, V, VII, IX, XI–XV. Palpal segments in proportion of 12:21:26:9:8, third segment markedly swollen, 1.53 times as long as greatest breadth, with very large, deep sensory pit. Mandible with 12 teeth.

Thorax.—Mesonotum dark pruinose grayish brown, with moderately prominent dark brown pattern, consisting of a median anterior longitudinal band, a pair of transverse marks over humeral pits and a larger triangular pair of marks at the sutural level. Scutellum black-

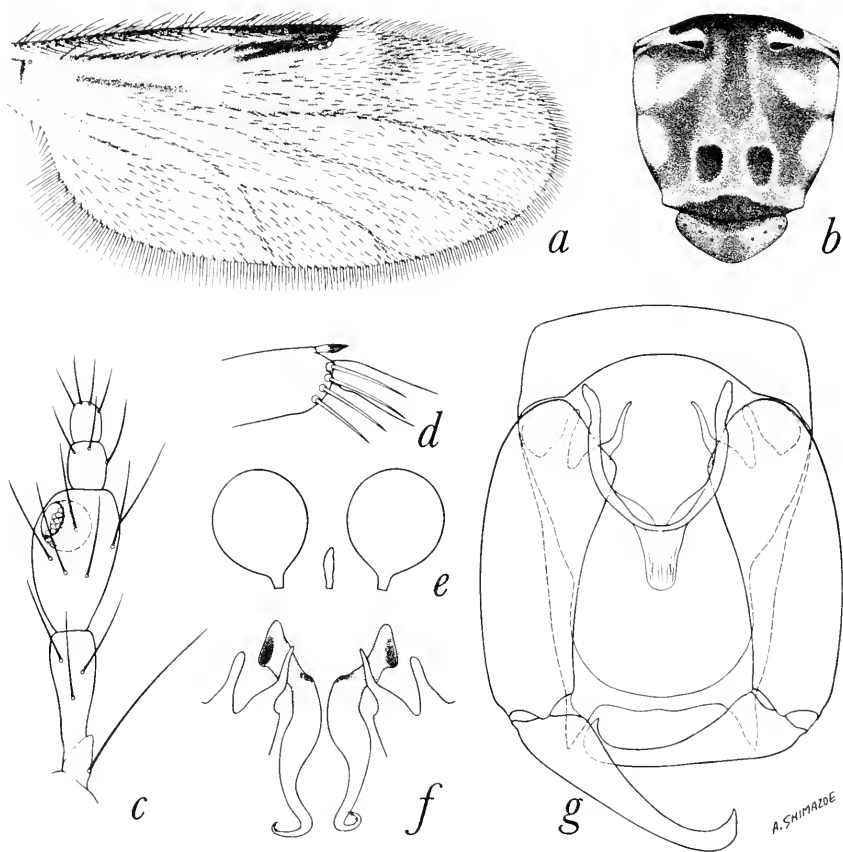


FIGURE 26.—*Culicoides commatis*, new species. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

ish in middle, dark brown on sides; postscutellum and pleuron blackish. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four spines, the second from the spur longest.

Wing.—Pattern as figured; second radial cell very dark; pale spot over r-m crossvein rounded, meeting costal margin in reduced breadth;

poststigmatic pale spot in cell R_5 not double, but transverse; distal pale spot in cell R_5 round, not meeting anterior wing margin, with a linear distal pale appendage extending from posterior side of spot nearly to wing tip in apex of cell R_5 ; distal pale spot in cell M_1 broadly meeting wing margin; pale spot present straddling middle of cell M_2 ; no pale marks on vein M_1 or at apices of medial branches; pale spot at apex of cell M_2 broadly meeting wing margin; pale spot in cell M_4 extending in full breadth from wing margin to vein M_{3+4} , without pale border on veins M_{3+4} or Cu_1 in base of cell M_4 , two pale spots in distal portion and one pale spot near base of anal cell, cell M_2 with pale spot present in front of mediocubital fork, none present behind medial fork. Macrotrichia numerous and long over entire wing; costa extending to 0.58 of distance to wing tip. Halter dull yellowish.

Abdomen.—Brownish black. Spermathecae two, subequal, pyriform, collapsed in type specimen and not measurable, with the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with broad, shallow, caudo-median excavation; ninth tergum long and slightly tapering with long pointed apicolateral processes, the caudal margin not notched. Basistyle with ventral root long and pointed, dorsal root slender; dististyle slender with bent, pointed tip. Aedeagus with moderately broad, pointed, basal arch, the basal arms well sclerotized and curved; distal portion with nearly parallel sides and bluntly rounded, moderately stout tip. Parameres each with large basal knob; stem sinuate, basal portion distinctly swollen, tapered distad to bent, pointed tip bearing a few minute hairs.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63160) and allotype male, Almirante, Bocas del Toro Province, Panama, December 1952, F. S. Blanton, light trap. Paratypes: 2 males, 1 female, same data except dates October to December 1952, and Apr. 27, 1953.

DISCUSSION: The wing markings, antennal sensoria, and structure of the male genitalia ally *commatis* with *pam-poikilus* Macfie, but *pam-poikilus* is larger (wing 1.25 mm. long), with distal antennal segments longer (antennal ratio, 1.39), the main body of the distal pale spot in cell R_5 not round, veins M_{3+4} and Cu_1 pale margined in base of cell M_4 and a pale spot present behind the medial fork. The male genitalia of *pam-poikilus* differ mainly in the greater development of the apicolateral processes with a deep notch between their bases on the caudal margin of the ninth tergum.

24. *Culicoides pampoikilus* Macfie

FIGURE 27

Culicoides pampoikilus Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 79 (female; Chiapas, Mexico; fig. wing).

Culicoides dominicii Ortiz, 1951, Nov. Cient. Mus. Hist. Nat. LaSalle, zool. ser., no. 5, p. 7 (male, Ocumare, Venezuela; fig. male palpus, wing, genitalia).—Mirsa and Ortiz, 1952, Bol. Lab. Clin. Luis Razetti, vol. 12, p. 476 (female; Los Choros, Venezuela; fig. wing, mesonotum, antenna, palpus, spermathecae). New synonymy.

FEMALE: Length of wing 1.25 mm.

Head—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 18:14:16:16:17:15:16:17:30:32:34:35:46, antennal ratio 1.39; distal sensory tufts present on segments III, v. VII, IX, XI–XV. Palpal segments in proportion of 10:22:32:9:9, third

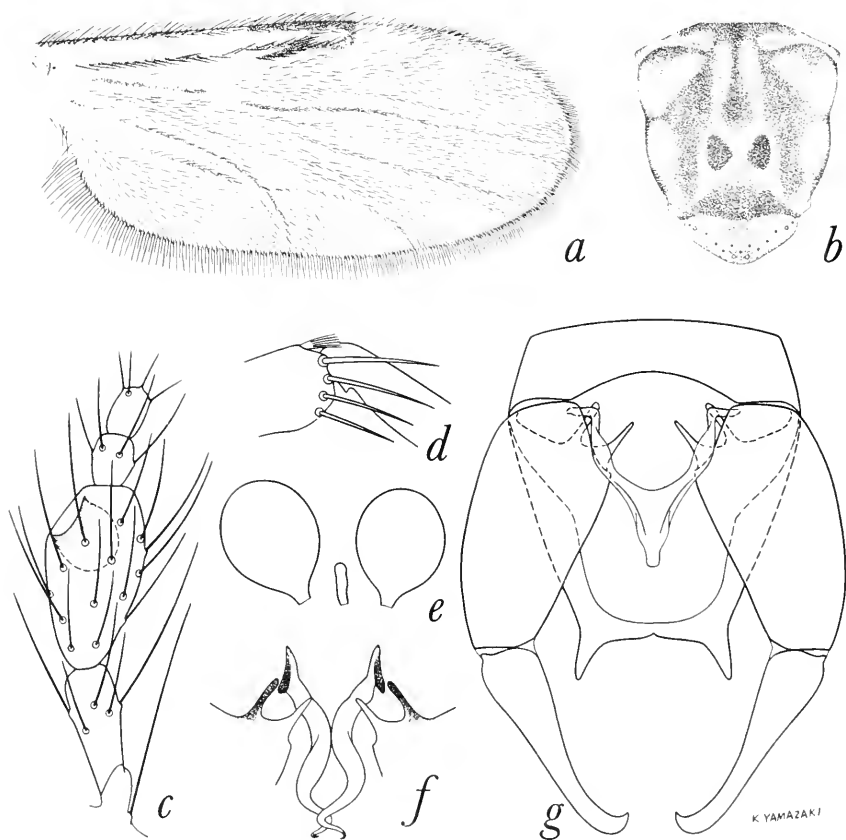


FIGURE 27.—*Culicoides pampoikilus* Macfie. a–e, Female: a, wing; b, thoracic pattern; c, palpus; d, tibial comb; e, spermathecae. f, g, Male: f, parameres; g, genitalia, parameres removed.

segment greatly swollen, 1.8 times as long as greatest breadth, with a large, deep, sensory pit opening by a small pore. Mandible with 14 teeth.

Thorax.—Mesonotum with prominent pattern as figured, consisting of a pair of sublateral dark brown broad longitudinal bands, with a pair of small anterior submedian spots and several lateral pairs of small spots, pruinose yellowish gray. Scutellum narrowly dark brown in middle, pale on sides; postscutellum and pleuron dark brown. Legs dark brown, knee spots blackish; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four spines, the second from the spur longest.

Wing.—Pattern as figured; pale spot over r-m crossvein broadly reaching costal margin; cell R_5 with single, transverse, poststigmatic pale spot and a small pale spot in middle of cell, the posterior margin of which is connected by a somewhat obscure, narrow pale line near posterior margin of cell to a smaller pale spot at wing margin in apex of cell; cell M_1 with an elongate pale spot at wing margin; vein M_2 straddled by a pale spot near its base; cell M_2 with a pale spot at wing margin; cell M_4 with a pale spot at wing margin connected anteriorly to a narrow pale line along posterior margin of vein M_{3+4} (Mirsa and Ortiz' figure shows this line also extending down distal margin of vein Cu_1); anal cell with two distal pale spots; cell M_2 with a pale spot lying in front of mediocubital fork and another lying behind medial fork; a small pale area at basal arculus and another lying on base of mediocubital stem. Macrotrichia dense and long, extending to bases of medial and anal cells; costa extending to 0.59 of distance to wing tip. Halter pale.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, oval, slightly unequal, measuring 0.043 by 0.034 mm. and 0.038 by 0.031 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with scarcely perceptible caudomedian excavation, ninth tergum tapered with large caudomedian notch and large, triangular, apicolateral processes. Basistyle with dorsal and ventral roots subequal, simple and slender; dististyle slender with hooked tip. Aedeagus with pointed basal arch extending to half of total length of aedeagus; distal portion tapered to simple, slender tip. Parameres each with slender anterior process on basal knob; stem rather stout and sinuate, tapered distally to simple, filiform tip abruptly bent ventrad.

DISTRIBUTION: Mexico; Venezuela; Panama.

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Cerro Punta, Volcán.

PANAMÁ PROVINCE: Cerro Campana.

DISCUSSION: This species is closely related to *commatis*, new species; for characters of separation see discussion under that species.

25. *Culicoides phaeonotus*, new species

FIGURE 28

FEMALE: Length of wing 1.06 (0.96–1.09, $n=7$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segment in proportion of 18:14:14:14:14:14:15:35:35:38:36:49, antennal ratio 1.63 (1.56–1.77, $n=6$): distal sensory tufts present on segments III, V, VII, IX, XI–XV. Palpal segments in proportion of 9:24:24:10:8, third segment short and greatly swollen, 2.0 (1.9–2.2, $n=7$) times as long as greatest breadth, with a broad, deep sensory pit. Mandible with 12 (12–13, $n=6$) teeth.

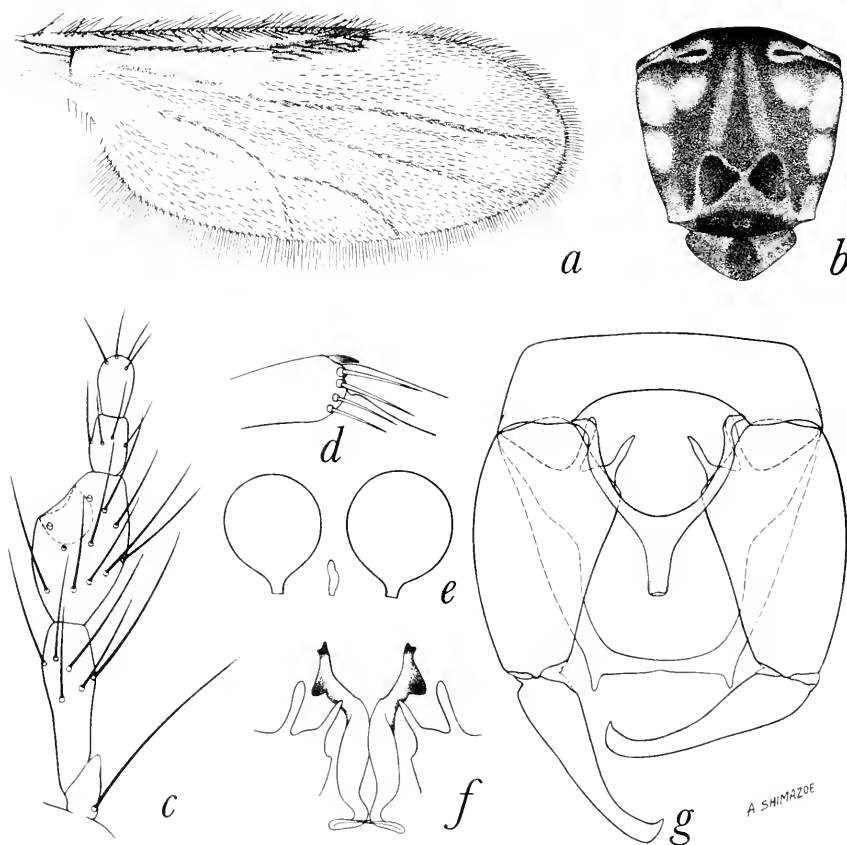


FIGURE 28.—*Culicoides phaeonotus*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum dark brown with prominent pattern of pruinose, grayish brown patches; a pair of very narrow, elongate, submedian anterior ones, and four pairs of small, rounded, lateral ones. Scutellum dark brown in middle, light brown on sides; post-scutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=7$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale spots relatively small and indistinct; small pale spot over r-m crossvein broadly reaching costal margin; a small, oblique, poststigmatic pale spot in cell R_5 ; distal pale spot in cell R_5 small and rounded, not meeting wing margin; no pale spots bordering vein M_1 ; pale spot in cell M_1 indistinctly approaching wing margin, elongate; small pale spot straddling middle of vein M_2 ; small pale spots at the wing margin in cells M_2 and M_4 , the one in cell M_4 broadly extending to vein M_{3+4} but not continued along that vein; two small, separated pale spots in distal portion of anal cell; pale spots present in cell M_2 , one in front of mediocubital fork and another behind medial fork. Macrotrichia very numerous and long, extending to base of wing in cell M_2 and anal cell; costa extending to 0.61 (0.59–0.66, $n=7$) of distance to wing tip. Halter brownish yellow.

Abdomen.—Brownish black. Spermathecae two, subspherical, subequal, measuring 0.038 by 0.034 mm. and 0.036 by 0.031 mm.

MALE GENITALIA: Ninth sternum with a broad, shallow, caudo-median excavation; ninth tergum long and tapering with short, triangular, pointed, apicolateral processes. Basistyle with ventral root short, slender and pointed, dorsal root longer and slender; dististyle very slender with markedly hooked, pointed tip. Aedeagus with basal arch reaching to two-thirds of total length, the basal arms bent in midportions; distal portion short and simple with moderately slender, truncated apex. Parameres each with basal knob bearing a long anterior process; stem slender at base, moderately bent before the moderately stout, nearly straight midportion, without ventral lobe, with distal portion twisted, only moderately narrowed to simple pointed tip.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63161), Almirante, Bocas del Toro Province, Panama, November 1952, F. S. Blanton, light trap. Allotype male and 10 male and 50 female paratypes, same data except dates October 1952 to March 1953.

DISCUSSION: This species is closely related to *daedalus* Macfie, which differs in having the pale spot in cell M_1 located far from the wing margin, in having a third basal pale spot in anal cell, and in

lacking sensoria on any of antennal segments IV to X. *Pilosus*, new species, of the *copiosus* group has a nearly identical wing pattern but differs in having a paler, more yellowish mesonotal pattern and sensoria present on all of segments III to IX.

26. *Culicoides dunni*, new species

FIGURE 29

FEMALE: Length of wing 1.12 ($n=2$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 18:14:15:15:15:15:15:15:21:24:27:28:38, antennal ratio 1.13, distal sensory tufts present on segments III, IV, VI, VII, IX and XI–XV on one antenna and on segments III, VI–IX (segments XI–XV missing) on other antenna of the single specimen available. Palpal segments in proportion of 11:21:36:8:9, third segment very large and swollen, 2.06–2.25 ($n=2$) times as long as greatest breadth, with a large deep pit opening by a small pore. Mandible with 18 teeth.

Thorax.—Mesonotum yellowish brown, blackish on anterior and lateral margins, with a moderately distinct, dark brown pattern consisting of a very narrow median anterior line and two short, broad, sublateral vittae at sutural level. Scutellum dark brown in middle, yellowish brown on sides; postscutellum and pleuron blackish. Legs

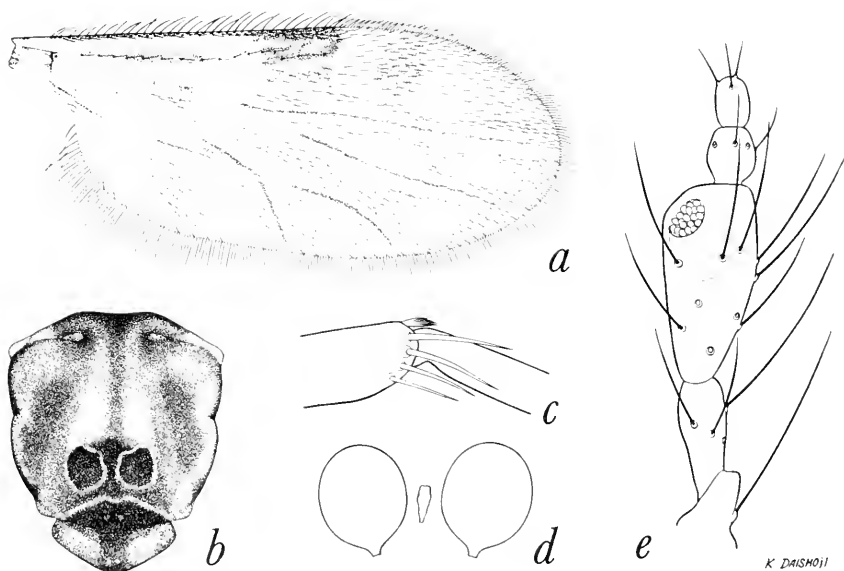


FIGURE 29.—*Culicoides dunni*, new species. Female: *a*, wing; *b*, thoracic pattern; *c*, tibial comb; *d*, spermathecae; *e*, palp.

blackish brown; fore and mid femora with subapical and all tibiae with subbasal, narrow pale rings; hind tibial comb with four spines, the two nearest the spur longest, subequal.

Wing.—Pattern as figured; three relatively dark anterior spots, the second entirely covering second radial cell; pale spot over r-m crossvein large, extending broadly to costal margin and through half the width of cell M_2 ; poststigmatic pale spot narrow, transverse, quadrate in shape, distal pale spot in cell R_5 of same size and shape or slightly shorter, a very dark spot in cell R_5 of the same size and shape between the pale spots; vein M_1 with an elongate pale spot lying on anterior side of vein or extending over it slightly into cell M_2 , at level of the poststigmatic pale spot in cell R_5 ; distal pale spot in cell M_1 lying far from wing margin; apices of veins without pale spots; a large pale spot straddling middle of vein M_2 ; distal pale spot in cell M_2 ; distal pale spot in cell M_2 not meeting wing margin; pale spot in cell M_4 broadly meeting wing margin and with narrow extension anteriorly to vein M_{3+4} ; anal cell with two pale spots in distal portion, the posterior one broadly meeting wing margin, one posterior spot far from wing margin in basal part of cell and a fourth pale area extending across mediocubital stem to halfway across base of cell M_2 ; cell M_2 also with a small pale spot lying in front of medio-cubital fork and a very small one behind medial fork. Macrotrichia numerous and long on entire wing, extending to base of cell M_2 and anal cell; costa extending to 0.56 of wing length. Halter yellowish.

Abdomen.—Brownish black, cerci dull yellowish. Spermathecae two, subspherical, subequal, small, measuring 0.046 by 0.036 mm., the bases of the ducts sclerotized a very short distance.

MALE: Unknown.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63162), Volcán, Chiriquí Province, Panama, December 1952, F. S. Blanton, light trap. Paratypes, 4 females, same data except three with dates Apr. 4, 1954.

DISCUSSION: *Culicoides propinquus* Macfie from Chiapas, Mexico, has a similar wing pattern which differs in having the pale spot lying in front of vein M_1 not crossing over the vein and lying distal to the level of the poststigmatic pale spot in cell R_5 . *C. propinquus* is known only from the male, whose genitalia place it definitely in the *copiosus* group near *poikilonotus* Macfie. The sensorial pattern of *dunni* allies it with the species of the *daedalus* group.

This species is dedicated to Dr. Lawrence H. Dunn, for many years medical entomologist and assistant director of the Gorgas Memorial Laboratory, in honor of his contributions to science in Panama.

27. *Culicoides daedaloides*, new species

FIGURE 30

FEMALE: Length of wing 0.92–1.09 ($n=2$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 18:14:12:13:13:13:12:14:28:28:31:32:43, antennal ratio 1.48–1.49 ($n=2$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 9:12:19:6:7, third segment short and swollen, 1.83–1.90 ($n=2$) times as long as greatest breadth, with a very broad and shallow sensory pit. Mandible with 12 teeth.

Thorax.—Mesonotum pruinose yellowish brown, with a prominent pattern of brown lines in the form of H-shaped marking, the longitudinal lines extending from the humeral pits to the sides of scutellum,

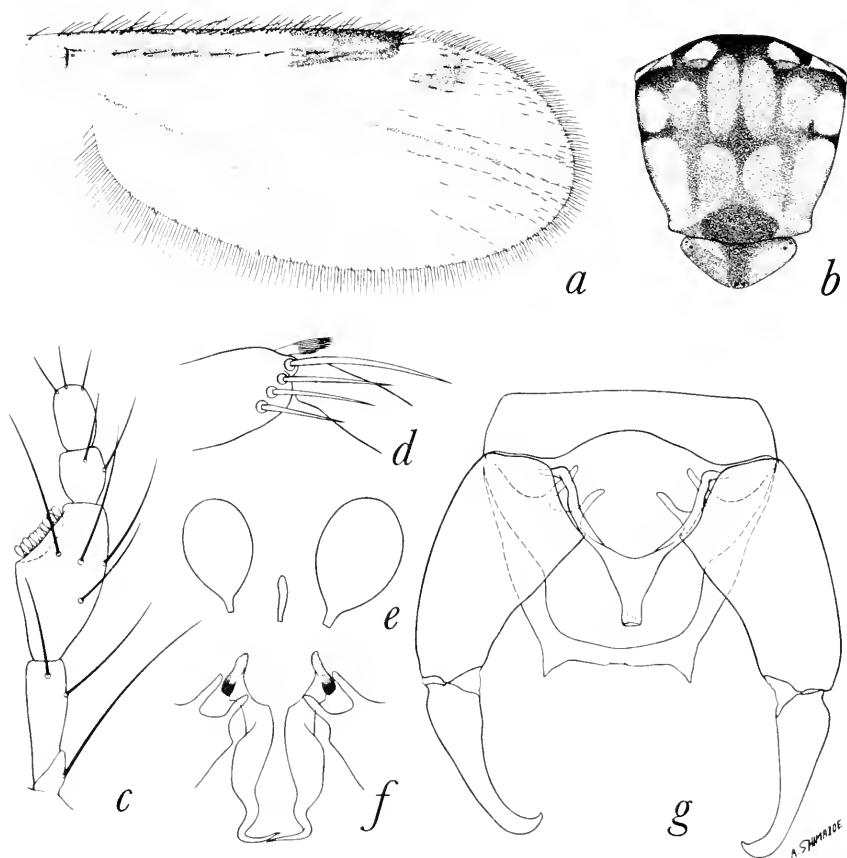


FIGURE 30.—*Culicoides daedaloides*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

the transverse line located at level of lateral sutures. Scutellum narrowly brown in middle, yellowish on sides; postscutellum and pleuron brownish. Legs brown; knee spots blackish, femora with subapical, tibiae with subbasal and hind tibiae with apical narrow pale rings; hind tibial comb with four ($n=2$) spines, the one nearest the spur longest, very long, 0.4 as long as basitarsus.

Wing.—Pattern as figured, second radial cell moderately dark; pale spot over r-m crossvein continued in full breadth to costal margin; poststigmatic pale spots in cell R_5 separate, round, the one behind second radial cell larger; distal pale spot in cell R_5 double, transverse, reaching anterior wing margin in full breadth; distal pale spot in cell M_1 oval, located far from wing margin; pale spot present straddling middle of vein M_2 ; one pale spot at the wing margin in distal part of cell M_2 ; pale spot in cell M_4 the same breadth from wing margin to posterior side of vein M_{3+4} ; a transverse, double pale spot in distal part of anal cell, a small pale spot over anal vein near base of anal cell; pale spot absent in front of mediocubital fork; pale spot behind medial fork and at basal arculus of wing. Macrotrichia very sparse on distal third of wing, none in cell M_4 and anal cell; costa extending to 0.63 ($n=2$) of distance to wing tip. Halter whitish.

Abdomen.—Dark brown. Spermathecae two, slightly unequal, pyriform, the larger measuring 0.053 by 0.036 mm. in holotype, the smaller collapsed in available specimens, bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with broad, very shallow, caudo-median excavation; ninth tergum tapering with short, triangular, apicolateral processes. Basistyle with ventral and dorsal roots slender, simple, the ventral root pointed; dististyle with slender, hooked, pointed apex. Aedeagus with basal arch reaching 0.6 of total length of aedeagus, rounded mesally, the basal arms slender and curved, the distal portion tapered to slender, simple tip. Parameres each with basal knob bearing a long anterior process, stem narrow at extreme base, stout on midportion and sinuate, apparently (?) bearing a very low, extensive ventral lobe, distal points simple, with a long twist ventromesad.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63163), Almirante, Bocas del Toro Province, Panama, Apr. 29, 1953, F. S. Blanton, light trap. Allotype male, same data except date November 1952. Paratypes, 1 male, 3 females: 1 male, 2 females, Cerro Campana, Panamá Province, July 2, Sept. 19, 1951; 1 female, Mojinga Swamp, Canal Zone, January 1952.

DISCUSSION: *Culicoides daedalus* Macfie has a similar wing pattern and male genitalia, but has the wing much hairier with the post-

stigmatic pale spots fused and the distal pale spot in cell R_5 not reaching wing margin and the pale spots in anal cell well separated, the mesonotum is dark brown and the hind femur is dark to the tip. The presence in *daedaloides* of antennal sensory tufts on segments VIII-X, the broad, shallow palpal pit, the transverse distal pale spot in anal cell and the sparsely hairy wings would exclude this species from the *daedalus* group and thus its true relations are still unknown.

The *copiosus* group

This group consists of small species with very hairy wing; the wing pattern of well-defined, rounded pale spots, a pale spot usually present straddling middle of vein M_2 or lying just in front of this vein and often with a similar spot on vein M_1 ; pale spot in cell M_4 usually widened toward vein M_{3+4} , crossvein r-m never darkened; female palpus with third segment greatly swollen and bearing a deep sensory pit usually opening by a smaller pore; spermathecae two; four tibial spines; male genitalia with dorsal and ventral roots of the basistyle simple, the ventral root never foot-shaped, parameres short with basal knob directed laterad, stem swollen at base, without ventral lobe, the apex slender, simple and often twisted, aedeagus usually short and broad, the basal arch usually low, the basal arms stout.

PANAMA SPECIES: Four: *jamaicensis* Edwards; *panamensis* Barbosa; *pilosus*, new species; and *poikilonotus* Macfie. (Other Neotropical species belonging to this group include *borinqueni* Fox and Hoffman, *copiosus* Root and Hoffman, *loughnani* Edwards and *propinquus* Macfie. Ryckman and Ames (1953) reared *copiosus* from rotting stems of cactus in Arizona.)

28. *Culicoides pilosus*, new species

FIGURE 31

FEMALE: Length of wing 0.99 ($n=3$) mm.

Head.—Eyes broadly separated, bare. Antenna with flagellar segments in proportion of 18:12:12:12:13:13:13:14:28:28:32:33:46, antennal ratio 1.56; distal sensory tufts present on segments III-IX and XI-XV. Palpal segments in proportion of 10:20:30:9:10, third segment greatly swollen, 2.0 (1.9-2.1, $n=3$) times as long as greatest breadth, with a large, very deep, sensory pit opening by a small pore. Mandible with 17 (16-18, $n=3$) teeth.

Thorax.—Mesonotum yellowish brown, with a moderately prominent pattern of large dark brown patches; a narrow median anterior line and a pair of lateral, broad bands at sutural level the most prominent; prescutellar area and anterior lateral margins also dark. Scutellum dark brown in middle, yellowish brown on sides; postscutellum

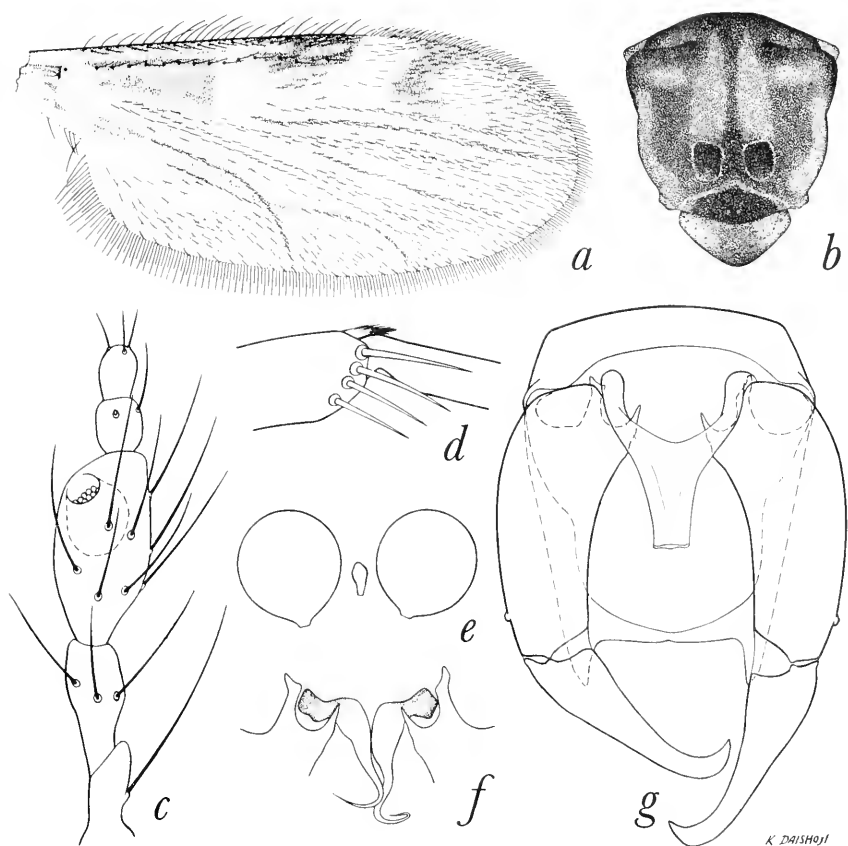


FIGURE 31.—*Culicoides pilosus*, new species. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

and pleuron dark brown. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=3$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale spot over r-m crossvein large, broadly but with reduced intensity reaching costal margin; post-stigmatic pale spot in cell R_5 large, nearly transverse; distal pale spot in cell R_5 irregularly rounded, not reaching wing margin, dark area between the two pale spots in cell R_5 , the area over second radial cell and the area proximad of r-m crossvein very dark brown; no pale spots on vein M_1 ; pale spot in cell M_1 elongate, reaching distal wing margin; pale spot present straddling middle of vein M_2 ; pale spots present at wing margin in cells M_2 and M_4 , the latter broadened and extended proximad a short distance along posterior side of vein M_{3+4} ; two separate spots in distal portion of anal cell and a third spot lying

over anal vein near base of cell; pale spot present in cell M_2 in front of mediocubital fork, none behind medial fork. Macrotrichia numerous and long, extending to base of wing in anal cell and cell M_2 ; costa extending to 0.59 ($n=3$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, subequal, ovoid, each measuring 0.036 by 0.031 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with very broad, very shallow, caudomedian excavation; ninth tergum short and broad with very slight caudomedian notch and very large, triangular apicolateral processes. Basistyle with dorsal root long and slender, ventral root about half as long, pointed; dististyle with slender, hooked tip. Aedeagus wedge-shaped with nearly straight sides and broad, truncated tip; basal arch extending to about a third of total length of aedeagus, formed by a very poorly sclerotized mesal membrane, the basal arms rather stout and well sclerotized, nearly straight. Parameres each with laterally directed basal knob, stem short and swollen at base, tapered to simple, slender, distally bent tip.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63164), Almirante, Bocas del Toro Province, October–December 1952, F. S. Blanton, light trap. Allotype male, Cerro Campana, Panamá Province, Sept. 19, 1952. Paratypes, 22 females: 13 females, Almirante, October 1952 to March 1953; 6 females, Cerro Campana, July 3, 1951, September 1952; 2 females, Mojinga Swamp, Canal Zone, December 1951; 1 female, El Valle, Coclé Province, Jan. 6, 1954.

DISCUSSION: The female of this species is similar to that of *daedalus* Macfie and *phaeonotus*, new species; for characters of separation see the discussion under *phaeonotus*. The male genitalia of *pilosus* are nearly identical with those of *panamensis* Barbosa, but in *panamensis* the basal knob and the basal swelling of the stem of the parameres are not so well developed, the aedeagal arch is usually higher and broader and the apicolateral processes are somewhat longer and more diverging.

29. *Culicoides panamensis* Barbosa

FIGURE 32

Culicoides panamensis Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 22 (male, female; Barro Colorado Island, Canal Zone; fig. palpus, male genitalia).—Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 114 (Guatemala; descriptive notes; fig. palpus, male genitalia; synonym, *alambiculatorum* Macfie).

Culicoides alambiculatorum Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 81 (female; Chiapas, Mexico; fig. wing).

FEMALE: Length of wing 0.87 (0.76–1.06, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar

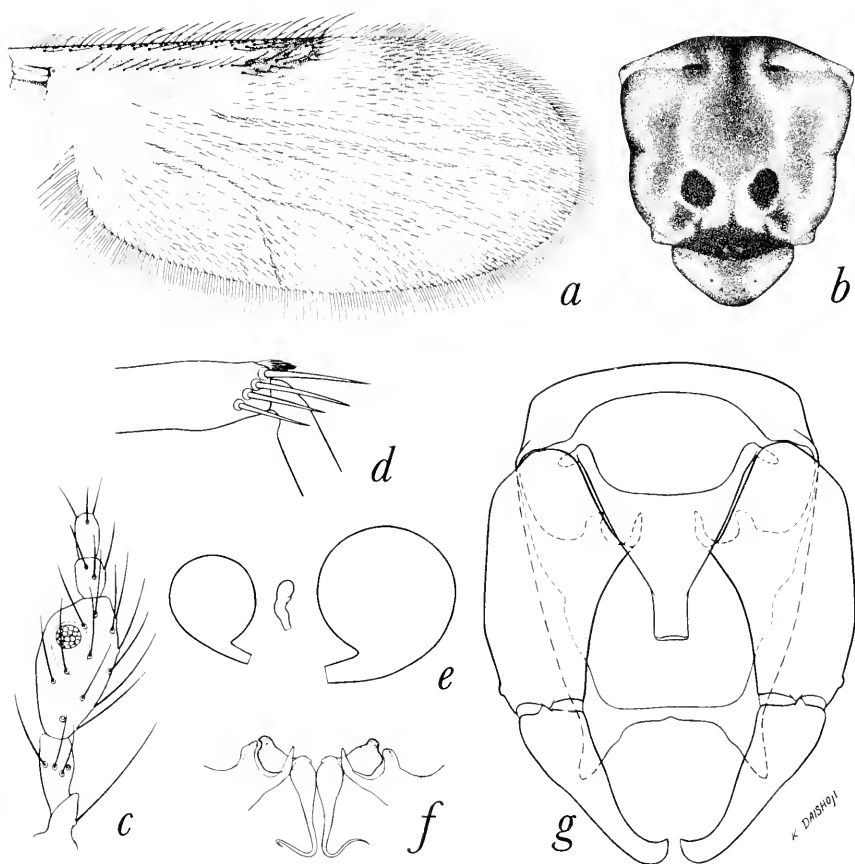


FIGURE 32.—*Culicoides panamensis* Barbosa. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

segments in proportion of 16:10:10:11:11:11:11:12:18:18:19:20:28, antennal ratio 1.12 (1.06–1.15, $n=6$); distal sensory tufts present on segments III, XI–XV. Palpal segments in proportion of 7:12:30:10:10, third segment greatly swollen, 2.0 (1.8–2.1, $n=9$) times as long as greatest breadth, with a large, deep pit opening through a very small pore. Mandible with 10 ($n=3$) teeth, very poorly developed, the teeth practically vestigial.

Thorax.—Mesonotum grayish brown pruinose, with three dark brown longitudinal bands, a median anterior one and two sublateral ones, each broadest in midportion. Scutellum, postscutellum, and pleuron dark brown. Legs dark brown, fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale spot over r-m crossvein small, but broadly attaining costal wing margin; poststigmatic pale spot in cell R_5 extending slightly caudad behind second radial cell, distal pale spot in cell R_5 rounded, not meeting wing margin; vein M_1 with a small pale spot straddling it near its base, sometimes this spot consisting only of the anterior portion lying in front of vein M_1 ; cells M_1 and M_2 each with one distal pale spot, that in cell M_1 not reaching wing margin, that in cell M_2 located at wing margin; pale spot in cell M_4 rounded, not following vein M_{3+4} ; one pale spot in apex of anal cell; pale spot present straddling middle of vein M_2 ; pale area in base of cell M_2 forming pale spots behind medial fork and in front of mediocubital fork. Macrotrichia long and dense, extending nearly but not quite to base of wing in cell M_2 and anal cell; costa extending to 0.55 (0.53–0.56, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Brownish. Spermathecae two, very unequal, retort-shaped, measuring 0.048 by 0.046 mm. and 0.035 by 0.028 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with a very broad, shallow, caudo-median excavation; ninth tergum long and tapering with very long, stout, slightly flaring, apicolateral processes. Basistyle with ventral root very slender, simple, dorsal root short and stout; dististyle short with stout base and hooked tip. Aedeagus stocky, with basal arch extending only to a fourth of total length of aedeagus, basal arms nearly straight; distal portion more or less in form of a truncated cone with broad apex. Parameres small, slender; each with a large, laterally directed, basal knob, base of straight portion of stem bulbously swollen, stem gradually narrowed to filiform, simple, ventrally bent tip.

DISTRIBUTION: Panama; Guatemala; Mexico.

PANAMA RECORDS:

CANAL ZONE: Barro Colorado Island (type locality).

CHIRIQUÍ PROVINCE: Volcán.

COCLÉ PROVINCE: El Valle.

LOS SANTOS PROVINCE: La Palma.

DISCUSSION: The reduced mandibles, remarkably enlarged third palpal segment with very deep pit and small pore, and retort-shaped spermathecae are distinctive features of this species. *Culicoides copiosus* Root and Hoffman from Mexico closely resembles *panamensis*, but has the distal pale spot in cell M_1 extending to the wing margin.

30. *Culicoides poikilonotus* Macfie

FIGURE 33

Culicoides poikilonotus Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 82 (female; Chiapas, Mexico; fig. wing).—Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 115 (Guatemala; male, female, descriptive notes; fig. mesonotum, palpus, male genitalia; synonym, *cacozelus* Macfie).

Culicoides cacozelus Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 85 (female; Chiapas, Mexico; fig. wing).

Culicoides hertigi Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 229 (male, female; Panama; fig. wing, mesonotal pattern, palpus, male genitalia).
New synonymy.

FEMALE: Length of wing 0.83 (0.76–0.92, $n=12$) mm.

Head.—Eyes contiguous above, bare. Antenna with flagellar segments in proportion of 17:11:12:12:12:12:13:23:23:23:24:34, antennal ratio 1.26 (1.18–1.32, $n=4$); distal sensory tufts present on seg-

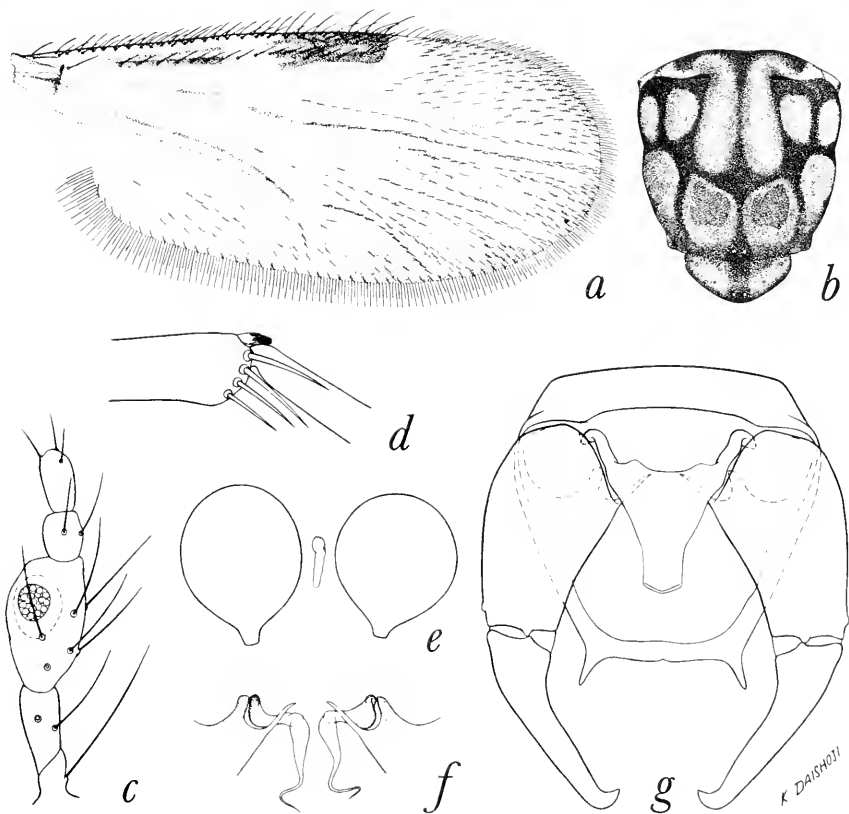


FIGURE 33.—*Culicoides poikilonotus* Macfie. a–e, Female: a, wing; b, thoracic pattern; c, palpus; d, tibial comb; e, spermathecae. f, g, Male: f, parameres; g, genitalia, parameres removed.

ments III, XI–XV. Palpal segments in proportion of 7:14:20:7:9, third segment short and swollen, 1.6 (1.4–1.8, $n=9$) times as long as greatest breadth, with a very deep, large sensory pit opening by a very small distal pore. Mandible with 10 (10–11, $n=3$) very small, almost vestigial teeth.

Thorax.—Mesonotum yellowish brown with a prominent pattern of narrow, darker brown bands as figured, principally a very narrow median longitudinal line extending from anterior margin to scutellum and a transverse band across sutural level with short, broader, anterior and posterior, lateral longitudinal extensions. Scutellum yellowish, narrowly dark brown in middle and on extreme ends; postscutellum brownish; pleuron yellowish, dark brown transversely across middle. Legs brownish, all femora with subapical, all tibiae with subbasal and hind tibia with apical narrow pale rings; hind tibial comb with four ($n=12$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, pale spot over r-m crossvein very small but extending in full width to costal margin; poststigmatic pale spot in cell R_5 double, the posterior part lying behind second radial cell; distal pale spot in cell R_5 transverse, not reaching anterior wing margin; veins M_1 and M_2 each with a narrow, elongate pale spot lying next to anterior side next to base of vein, the two at nearly the same longitudinal level, the pale spot lying next to vein M_2 , in Panama and Guatemala material only, rarely may be extended caudad to straddle the cell (typical form), usually lying entirely in front of cell (? variety *cacozelus*); pale spots in apices of cells M_1 and M_2 far removed from wing margin; apices of veins M_1 , M_2 and M_{3+4} each with a pale spot at wing margin; pale spot in cell M_4 with broadened extension bordering posterior margin of vein M_{3+4} ; three pale spots in anal cell, one at base and two in distal portion; small pale spots present lying behind medial fork and in front of mediocubital fork. Macrotrichia numerous but not dense, extending to base of cell M_2 and over distal half of anal cell; costa extending to 0.61 (0.59–0.62, $n=12$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown, proximal terga pale grayish. Spermathecae two, slightly pyriform, subequal, each measuring 0.043 by 0.034 mm., the bases of the ducts not sclerotized.

MALE GENITALIA.—Ninth sternum without caudomedian excavation; ninth tergum short and tapered with distinct caudomedian notch and very slender apicolateral processes. Basistyle with ventral root very slender, pointed, dorsal root stouter; dististyle slender with hooked, pointed tip. Aedeagus with basal arch rounded, extending to about a third of total length of aedeagus; posterior portion tapered to a relatively stout, truncated tip. Parameres each with large, lat-

erally directed, basal knob; base of stem not greatly swollen, stem gradually tapered to very slender, filiform, simple, twisted tip.

DISTRIBUTION: Mexico; Guatemala; Honduras (Lancetilla); Nicaragua (Villa Somoza); Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Fort Sherman, Mindi Dairy, Mojinga Swamp.

COCLÉ PROVINCE: El Valle, Río Hato (type locality of *hertigi*).

LOS SANTOS PROVINCE: La Palma, Las Tablas.

PANAMÁ PROVINCE: Cerro Campana, Isla Taboga.

DISCUSSION: Except for the difference in the extent of the pale spot in front of (*cacozelus*) or straddling (*poikilonotus*) the base of vein M_2 , *cacozelus* seems to be identical with *poikilonotus*. A few specimens with *poikilonotus* wing markings are present in the series from Almirante as well as the series studied from Yepocapa, Guatemala, along with the much commoner and more widespread *cacozelus* type. At the time we described *hertigi* we were not sufficiently familiar with the Mexican species, but we now are convinced of the synonymy. The great reduction in the mandibles, as well as the wing pattern and antennal and palpal structure, ally *poikilonotus* with *panamensis* Barbosa, which, however, can readily be recognized by the pale spots straddling veins M_1 and M_2 and by the very unequal, retort-shaped spermathecae.

31. *Culicoides jamaicensis* Edwards

FIGURE 34

Culicoides loughnani var. *jamaicensis* Edwards, 1922, Bull. Ent. Res., vol. 13, p. 165 (female; Jamaica; fig. wing).—Hoffman, 1925, Amer. Journ. Hyg., vol. 5, p. 283 (Canal Zone).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 21 (Jamaica, St. Croix, Panama; fig. male genitalia).—Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 80 (Chiapas, Mexico; female descriptive notes).—Fox, 1949, Bull. Brooklyn Ent. Soc., vol. 44, p. 32 (Puerto Rico; fig. female palpus, mesonotum, male genitalia).

Culicoides jamaicensis, Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 112 (Guatemala; fig. male genitalia).

FEMALE: Length of wing 0.97 (0.89–1.06, $n=16$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:10:11:12:12:13:14:14:20:21:21:22:30, antennal ratio 1.21 (1.12–1.32, $n=8$); distal sensory tufts present on segments III to XV. Palpal segments in proportion of 10:20:37:10:10, third segment very large and swollen to apex, 2.2 (1.9–2.3, $n=16$) times as long as greatest breadth, with a very large, deep, sensory pit

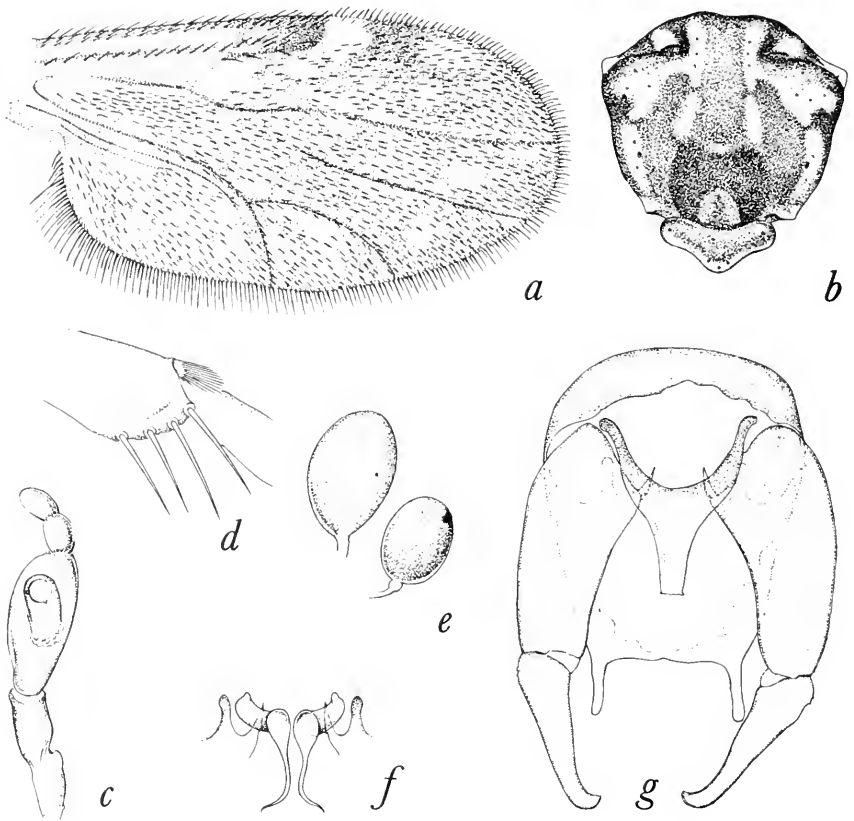


FIGURE 34.—*Culicoides jamaicensis* Edwards. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

opening by a small distal pore. Mandible with 15 (14–17, $n=9$) teeth.

Thorax.—Mesonotum with pattern as figured, dark pruinose gray, with three broad, dark brown bands, the median band extending from anterior margin to prescutellar depression and the lateral bands from behind humeral pits to ends of scutellum; these three bands bordered by conspicuous, narrow, whitish pruinose lines. Scutellum dark brown in middle, gray on sides; postscutellum and pleuron dark brown. Legs dark brown; femora pale at bases, femora with subapical and tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=15$) spines, the second from the spur very slightly the longest.

Wing.—Pattern as figured, pale spot over *r-m* crossvein small but broadly reaching costal margin; cell R_5 with four pale spots arranged in a rhomboid, the proximal and distal pairs each sometimes fused into oblique, double spots, the anterior portions of which lie at anterior

wing margin; small, double pale spots present straddling base of vein M_1 and middle of vein M_2 ; one pale spot in apex of cell M_1 and one in cell M_2 , well removed from wing margin; pale spot in cell M_4 broadest along posterior margin of vein M_{3+4} ; two pale spots in apex and one at base of anal cell; pale spot at wing base and one straddling middle of stem of mediocubitus; pale spots at wing margin at apices of veins M_1 , M_2 and M_{3+4} . Macrotrichia very dense, covering entire wing; costa extending to 0.57 (0.54–0.59, $n=16$) of distance to wing tip. Halter pale.

Abdomen.—Brownish black. Spermathecae two, oval, unequal, measuring 0.046 by 0.037 and 0.037 by 0.031 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with scarcely perceptible caudomedian excavation; ninth tergum tapered, with extremely long and slender apicolateral processes. Basistyle with ventral and dorsal roots slender and simple, the ventral roots pointed apically; dististyle short and tapered to slender, hooked apex. Aedeagus with round basal arch extending nearly to half of total length, basal arms stout and curved; distal portion stout and tapered to rather broad, truncated apex. Parameres small, each with stout lateral arms at base, stem swollen bulbously at base, tapered very rapidly to very slender, simple tip abruptly bent ventrolaterad.

DISTRIBUTION: Jamaica, Puerto Rico, Virgin Islands, Trinidad (Port Delgada), Venezuela, Panama, Honduras (Lago Yojoa, Tela), Nicaragua (Tela, Villa Somoza), Guatemala, Mexico, United States (Kerrville, Texas).

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Ancón, Gamboa, Loma Boracho, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Chirú.

COCLÉ PROVINCE: Penonomé, Puerto Farallón, Río Hato, Tranquilla.

DARIÉN PROVINCE: Garachiné, Punta Patiño.

HERRERA PROVINCE: Puerta Chitré.

LOS SANTOS PROVINCE: Guararé, La Palma, Pan de Azúcar, San José.

PANAMÁ PROVINCE: Camarón, Chepo, El Coco, La Jolla, Río Las Lajas, Isla Toboga, Tocumen.

VERAGUAS PROVINCE: Río Santa María, San Francisco.

DISCUSSION: This species is widely distributed around the Caribbean from Texas to Venezuela and Trinidad. It was long called a variety of *loughnani* Edwards from Jamaica (from whence both species were described at the same time) and Florida (Foote and Pratt, 1954), but no *loughnani* specimens, with their extensive pale wing markings and long male apicolateral processes and parameres, have been seen from the Central American *jamaicensis* localities, and we believe there are two distinct species. *Culicoides bakeri* Vargas from Mexico

is also closely related to *jamaicensis*, but *bakeri* has the pale spot at the end of vein M_1 continued proximad as a pale border to the vein to the pale spot straddling this vein near its base, there is no pale spot at the apex of vein M_{3+4} and the male parameres are spinose at the tips.

The *iriartei* group

This group consists of small to medium-sized species with moderately hairy wings; wing with pale spot present straddling middle of vein M_2 and usually with one or two linear pale spots lying in front of vein M_1 toward its base; female antenna with sensoria present on segments III, VII-X; four spines in tibial comb; two spermathecae; male genitalia with ventral root of the basistyle long and curved and foot-shaped with a prominent basal hook, parameres with large basal knob, the base not directed laterad, the apex with fringing spines; aedeagus with bladelike projections on the caudolateral margin of the arch.

PANAMA SPECIES: Two: *evansi*, new species, and *iriartei* Fox. (*C. blantoni* Vargas and Wirth from Mexico and *C. baueri* Hoffman from the United States also belong to this group.)

32. *Culicoides evansi*, new species

FIGURE 35

FEMALE: Length of wing 1.17 (1.12-1.23, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 18:13:13:14:15:14:14:15:20:20:22:24:38, antennal ratio 1.02 (0.90-1.09, $n=3$); distal sensory tufts present on segments III, VII-X. Palpal segments in proportion of 10:17:31:10:10, third segment greatly swollen, 2.0 (1.8-2.3, $n=10$) times as long as greatest breadth, with a very broad, moderately deep, sensory pit. Mandible with 13 (12-14, $n=8$) teeth.

Thorax.—Mesonotum rich chocolate brown, with prominent pattern of pruinose gray patches, consisting mainly of a submedian anterior pair of elongate spots, a pair of similar shape and position in flattened prescutellar area, and several small spots over humeral pits and along lateral margins. Scutellum dark brown in middle, pruinose gray on sides; postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical, all tibiae with subbasal, and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, pale spot over r-m crossvein narrow but broadening as it reaches costal margin; cell R_5 with two double, transverse pale spots, both broadly meeting anterior wing margin, each of these sometimes separated into two distinct small rounded

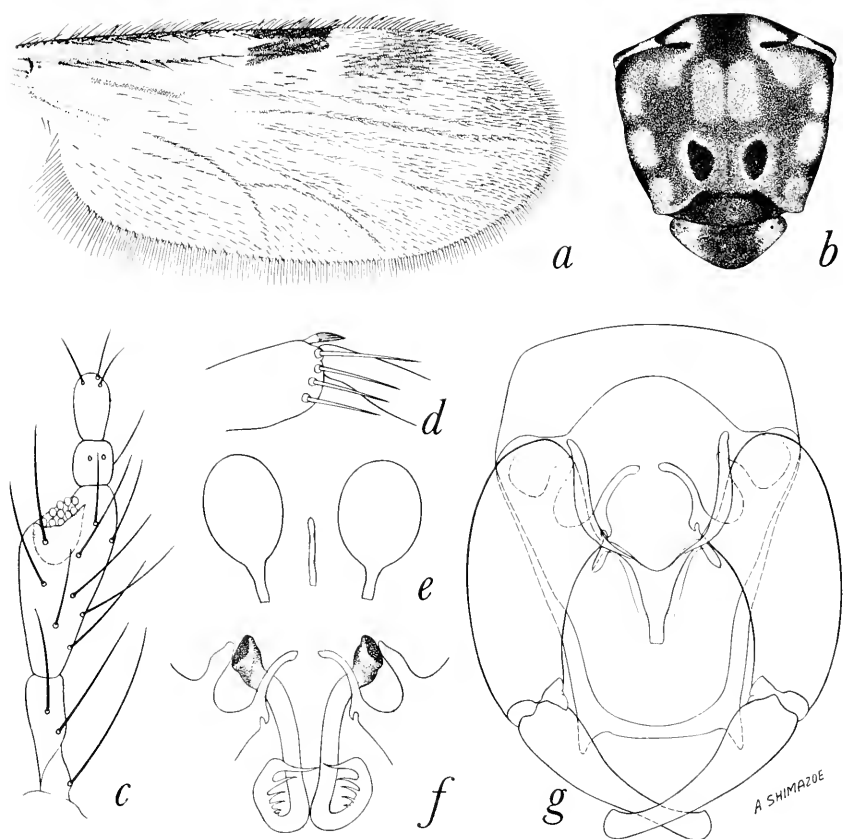


FIGURE 35.—*Culicoides evansi*, new species. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

spots; no pale spots or areas straddling or lying next to vein M_1 ; cell M_1 with a small round pale spot lying far from wing margin; a pale spot straddling middle of vein M_2 , a small pale spot lying near wing margin in apex of cell M_2 and another in cell M_4 ; only one pale spot in apex of anal cell and a small pale spot lying behind medial fork. Macrotrichia dense and very long over entire wing; costa extending to 0.57 (0.55–0.58, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Blackish brown. Spermathecae two, subequal, pyriform, measuring 0.071 by 0.047 mm. and 0.072 by 0.041 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with a broad, deep, caudomedian excavation; ninth tergum long and tapering with small apicolateral processes. Basistyle with ventral root foot-shaped, very slender, the

posterior heel small, the toe very long, slender and arcuate; dorsal root relatively stout; dististyle stout and slightly curved with bluntly rounded apex. Aedeagus with basal arch extending to about two-thirds of total length of aedeagus, distal mesal portion not rounded but with cleft continuing nearly to tip of apical portion of aedeagus; basal arms very slender and curved, a pair of short, bladelike processes on shoulders of basal arms; distal tip of aedeagus slender and simple. Parameres each with large basal knob, nearly straight, slender stem without ventral lobe and distal portion abruptly bent ventrad and bearing a lateral fringe of four large spines and a larger, bent, apical spine.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63165), allotype male, Volcán, Chiriquí Province, Panama, Apr. 17, 1952, F. S. Blanton, light trap. Paratypes, 12 males, 50 females; same data as type, except dates December 1952 and Mar. 25 to Apr. 23, 1954.

DISCUSSION: The male genitalia of *evansi* are nearly identical with those of *baueri* Hoffman from North America and *iriartei* Fox to which it is closely related. In both the related species there are definite, elongated pale spots lying just in front of vein M_1 , there are pale spots at the wing margin at the apices of veins M_1 to Cu_1 , and vein M_{3+4} is pale bordered. In *iriartei*, moreover, there are pale subapical bands on the hind femur.

We take great pleasure in dedicating this species, which is presently known only from the Panama Volcán area, to Mr. Thomas Evans, of the Walter Reed Army Institute of Research.

33. *Culicoides iriartei* Fox

FIGURE 36

Culicoides iriartei Fox, 1952, Ann. Ent. Soc. Amer., vol. 45, p. 368 (female; La Salina, Venezuela; fig. wing, palpus, spermathecae, tibial comb); 1955, Journ. Agr. Univ. Puerto Rico, vol. 39, p. 243 (synonym, *vargasi* Wirth and Blanton).

Culicoides baueri Ortiz and Mirsa (misident., not Hoffman), 1952, Rev. Sanid. Asist. Soc., vol. 16, p. 599 (male, female; Ocumare, Venezuela; fig. palpus, spermathecae, wing, male genitalia).

Culicoides vargasi Wirth and Blanton, 1953, Journ. Washington Acad. Sci., vol. 43, p. 74 (male, female; Panama; fig. wing, mesonotum, palpus, male genitalia).

FEMALE: Length 0.93 (0.89–0.92, $n=10$) mm.

Head.—Eyes nearly contiguous, bare. Antenna with flagellar segments in proportion of 15:12:12:12:12:12:12:20:22:25:28:36, antennal ratio 1.42 (1.36–1.46, $n=7$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 8:15:25:9:11, third segment swollen, 2.0 (1.9–2.2, $n=9$) times as long as greatest

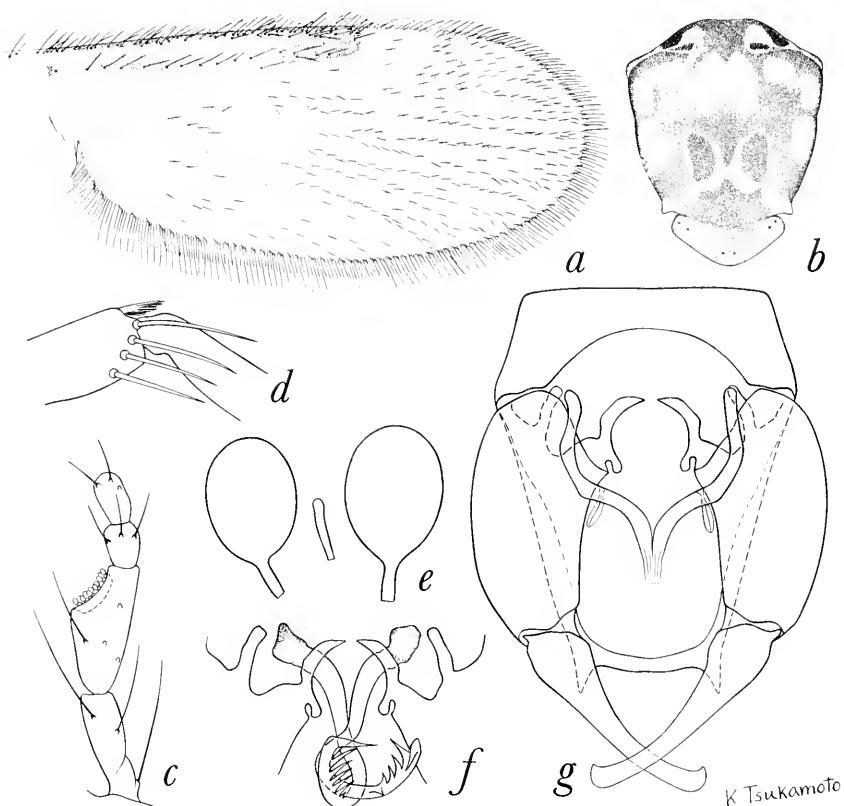


FIGURE 36.—*Culicoides iriartei* Fox. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

breadth, with a broad, shallow sensory pit. Mandible with 11 (11-12, $n=9$) teeth.

Thorax.—Mesonotum dark brown, with prominent pattern of large pruinose gray patches as figured, including a submedian anterior pair of large oval spots and several pairs of spots along lateral margins. Scutellum gray, brown in middle. Postscutellum and pleuron dark brown. Legs dark brown; femora with subapical, tibiae with basal and hind tibia with apical narrow pale rings; hind tibial comb with four ($n=8$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, second radial cell in a very dark spot; pale spot over crossvein r-m broadly continued to costal margin; cell R_5 with two, oblique to transverse, double spots reaching anterior wing margin, one at apex of second radial cell, the other subapical; two small, elongate pale spots in cell R_5 lying adjacent to vein M_1 ,

one halfway between crossvein and poststigmatic pale spot, the other halfway between the poststigmatic spot and the distal pale spot in cell R_5 ; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 pale a considerable distance from wing margin; distal pale spot in cell M_1 lying far removed from wing margin; pale spot present straddling middle of vein M_2 ; distal pale spot in cell M_2 small and not reaching wing margin; pale spot in cell M_4 touching vein M_{3+4} and continued along posterior margin of this vein to base of cell M_4 ; anal cell with one pale spot in distal portion; a pale spot present in cell M_2 behind medial fork and another present in front of mediocubital fork. Macrotrichia sparse and in rows on distal third of wing and a few in anal cell; costa extending to 0.61 (0.59–0.61, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, pyriform, subequal, measuring 0.065 by 0.041 and 0.058 by 0.036 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA. Ninth sternum with broad, deep, caudomedian excavation; ninth tergum long and tapered, with short, triangular apicolateral processes. Basistyle with ventral root long, curved and slender, with a small caudal hook, dorsal root nearly as long; dististyle slender and slightly curved. Aedeagus with basal arch broad and pointed, basal arms slender and curved, each bearing a bladelike process on posterior margin slightly caudad of midlength; distal portion slender and simple with serrated tip. Parameres each with large basal knob, stem slender and nearly straight, ventral lobe lacking, distal portion abruptly bent ventrad, and bearing a fringe of 4–6 sharp spines and a strong, bent distal spine.

DISTRIBUTION. Venezuela; Honduras (Lancetilla); Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort San Lorenzo, Fort Sherman, Loma Boracho, Madden Dam, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Concepción.

COCLÉ PROVINCE: Antón, Aguadulce, Coclé, El Valle, Penonomé, Poerí, Puerto Farallón, Río Hato.

COLÓN PROVINCE: Espino, Piña.

DARIÉN PROVINCE: El Real, Garachiné.

HERRERA PROVINCE: Ocu, Pesé, Puerto Chitré.

LOS SANTOS PROVINCE: Guararé, La Palma, Las Cruces, Las Lajas, Las Tablas (type locality of *vargasi*), Los Santos, Macaracas, Puerto Mensabe, Quemado, San José.

PANAMÁ PROVINCE: Bayano, Naranjal.

VERAGUAS PROVINCE: Río Santa María, Santiago.

DISCUSSION: *C. iriartei* is closely related to *C. baueri* Hoffman from the United States, *C. blantonii* Vargas and Wirth from Mexico, and *C. evansi*, new species, from Panama. *C. baueri* differs in having

only one pale line bordering the anterior side of vein M_1 and lying directly behind the poststigmatic pale spot in cell R_5 , and the hind femora and tibiae lack the distal pale bands. The female of *blantoni* is nearly identical with *iriartei* but the male paramere has a long ventral pouch. *C. evansi* has male genitalia almost identical with those of *iriartei*, but is a much larger species (wing 1.17 mm. long) and there are no pale spots lying adjacent to the anterior side of vein M_1 .

The *scopus* group

This group consists of large species with hairy wing; wing with r-m crossvein infuscated, pale spots present straddling middle of veins M_1 and M_2 , apices of veins not pale; female antenna with sensoria present on segments III, VIII, x-xv; palpal pit broad and shallow; two spermathecae; four tibial spines; male genitalia with ventral root of basistyle simple, small and pointed, paramere with basal knob not directed laterad but with distinct anterior process, the stem long without ventral lobe and apex with fringing spines; tergum with deep mesal cleft and large apicolateral processes.

PANAMA SPECIES: One: *scopus* Root and Hoffman. (*C. dampfi* Root and Hoffman from Mexico also belongs to this group.)

34. *Culicoides scopus* Root and Hoffman

FIGURE 37

Culicoides scopus Root and Hoffman, 1937, Amer. Journ. Hyg., vol. 25, p. 170 (male, female; San Jacinto, Mexico; fig. wing, male genitalia).

FEMALE: Length of wing 1.34 (1.15–1.78, $n=12$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 17:12:13:13:13:13:14:14:30:30:32:32:50, antennal ratio 1.65 (1.57–1.76, $n=3$); distal sensory tufts present on segments III, VIII, x-xv. Palpal segments in proportion of 10:25:31:10:12, third segment swollen toward apex, 2.1 (1.7–2.5, $n=9$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 15 (14–16, $n=9$) teeth.

Thorax.—Mesonotum golden brown pruinose, without prominent pattern. Scutellum, postscutellum and pleuron dark brown. Legs dark brown; knees blackish; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; large pale area over wing base; r-m crossvein blackish, in the middle of a large round pale spot broadly meeting costal margin and extending past vein M_{1+2} into cell M_2 ; small round pale spot distal to end of costa at wing margin in cell R_5 ; distal pale spot in cell R_5 transversely rectangular, extending from

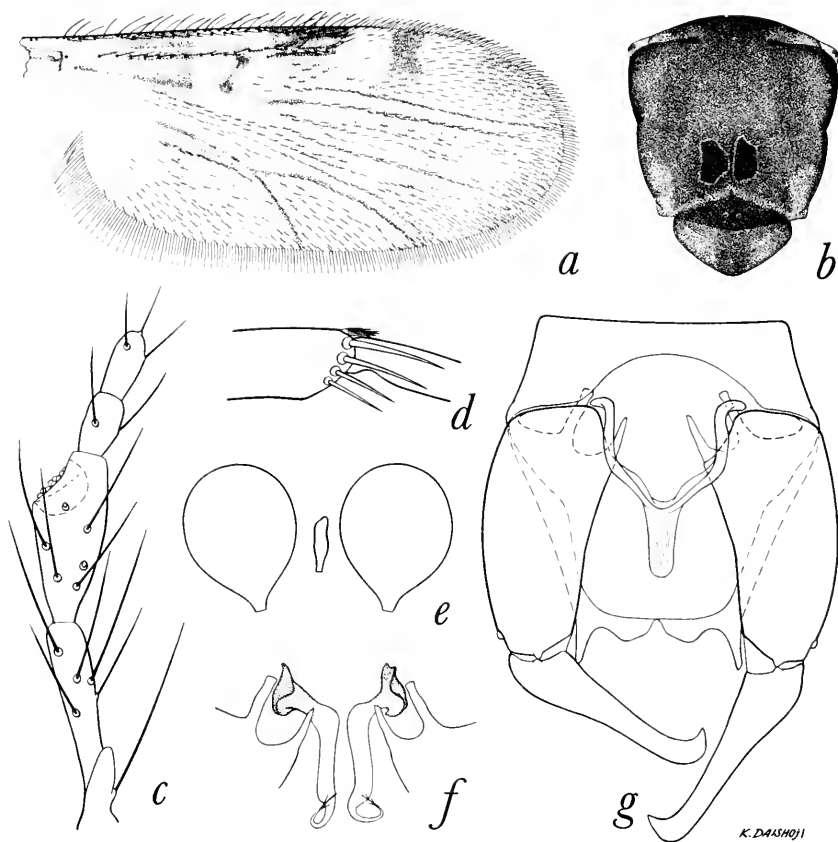


FIGURE 37.—*Culicoides scopus* Root and Hoffman. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

wing margin to anterior side of vein M_1 ; pale spot straddling base of vein M_1 , a larger pale spot straddling middle of vein M_2 ; a round subapical pale spot in cell M_1 , a spot at wing margin in apices of cells M_2 and M_4 ; two round, well separated pale spots in distal part of anal cell and a long pale spot lying in front of mediocubital fork. Macrotrichia long, numerous and well distributed, extending to base of wing; costa extending to 0.58 (0.51–0.62, $n=12$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, subequal, pyriform, measuring 0.053 by 0.038 mm. and 0.050 by 0.041 mm., the bases of the ducts sclerotized a very short distance.

MALE GENITALIA: Ninth sternum with a broad, relatively deep, caudomedian excavation; ninth tergum long and tapered, with very large, triangular, apicolateral processes and distinct caudomedian

notch. Basistyle with ventral and dorsal roots subequal, slender, simple; dististyle slender, sinuate with distinctly hooked apex. Aedeagus with rounded basal arch extending to about half of total length of aedeagus, the basal arms distinctly curved; distal portion simple, slender, tapered to rounded apex. Paramere with large basal knob, base of stem slender, abruptly bent, then swollen on sinuate midportion, no ventral lobe, apex slender and bent ventromesad with a few subapical, very fine hairs.

DISTRIBUTION: Mexico; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CHIRIQUÍ PROVINCE: Volcán.

COCLÉ PROVINCE: Hermita.

DISCUSSION: This species has no close Panama relatives, but belongs to a distinct Central American group along with the Mexican species *dampfi* Root and Hoffman, both species having a similar wing pattern with r-m crossvein darkened and pale spots straddling both veins M_1 and M_2 , and similar male genitalia. *C. dampfi* has much more extensive wing spots than *scopus* and the stems of the male parameres are straight.

The *limai* group

This group consists of small species with wing pattern of large pale spots filling the cells, pale spots present straddling veins M_1 and M_2 in some species; female antenna with sensoria present on segments III, VII–X (present on XI–XIV only in the doubtful species *carpenteri*); four tibial spines; two spermathecae; male genitalia with ventral root of the basistyle foot-shaped; paramere with simple basal knob, apex fringed, stem straight, ventral lobe present or absent; aedeagus Y-shaped with simple tip; ninth tergum with narrow apex and short apicolateral processes.

PANAMA SPECIES: Four, possibly six: *camposi* Ortiz and Leon, *galindoi* Wirth and Blanton, *limai* Barretto, and *tenuilobus*, new species. Two species, *carpenteri* Wirth and Blanton and *magnipalpis* Wirth and Blanton, are provisionally referred here but their group position is uncertain.

35. *Culicoides galindoi* Wirth and Blanton

FIGURE 38

Culicoides galindoi Wirth and Blanton, 1953, Journ. Washington Acad. Sci., vol. 43, p. 73 (male, female; Panama; fig. wing, mesonotum, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 0.83 (0.73–0.89, $n=15$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 17:12:14:15:15:14:14:15:18:20:22:20:30, antennal ratio

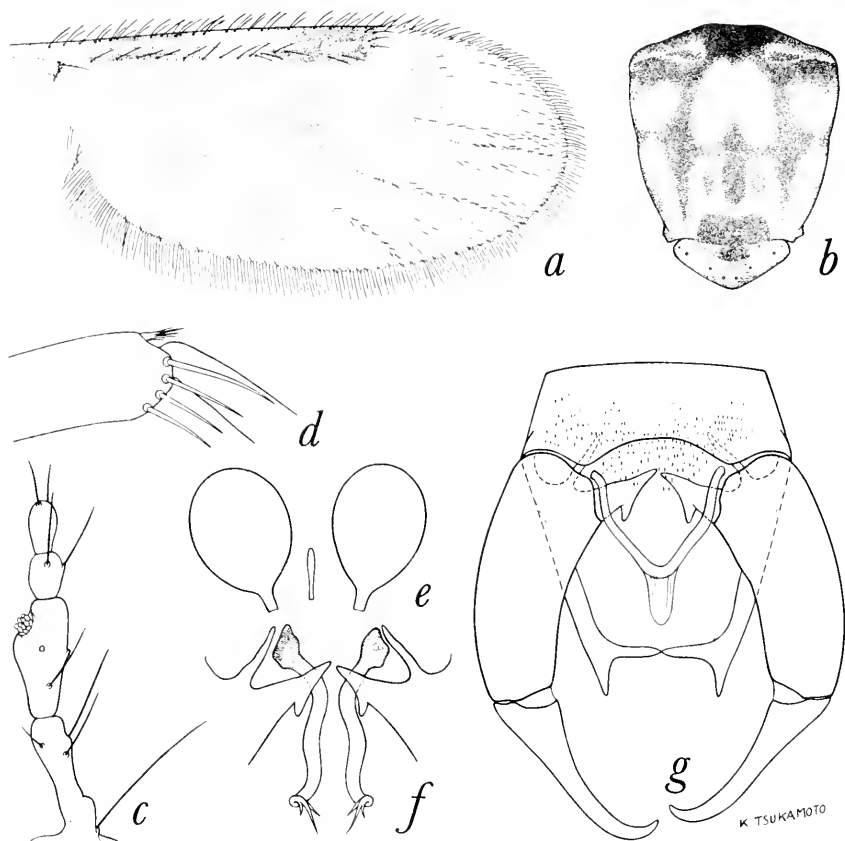


FIGURE 38.—*Culicoides galindoi* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

0.95 (0.91–1.00, $n=10$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 8:18:20:9:10, third segment slightly swollen, 2.1 (2.0–2.3, $n=14$) times as long as greatest breadth, with a small, shallow, sensory pit. Mandible with 14 (12–15, $n=14$) teeth.

Thorax.—Mesonotum dark brown with extensive, pruinose, yellowish patches as figured, principally two elongate submedian anterior marks, two pairs of lateral spots and extensive pale prescutellar area; postscutellum and pleuron dark brown, pleuron yellowish on dorsal half. Legs dark brown, fore and mid femora with subapical and all tibiae with subbasal pale rings; hind tibial comb with four ($n=14$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, ends of cells R_5 , M_1 , M_2 and anal cell with large pale areas extending broadly to wing margin, ends of the

branches of media and cubitus dark, two pale spots in cell M_2 beyond the pale spot in front of mediocubital fork, the proximal spot in cell M_1 completely filling the space between veins M_1 and M_2 but usually not appearing to straddle these veins, distal pale spot in anal cell consisting of two broadly fused spots. Macrotrichia sparse in apices of cells R_5 , M_1 and M_2 ; costa extending to 0.62 of distance to wing tip. Halter pale.

Abdomen.—Dull brownish black. Spermathecae two, pyriform, subequal, measuring 0.048 by 0.032 mm. and 0.043 by 0.029 mm.

MALE GENITALIA: Ninth sternum with shallow caudomedial excavation, the posterior membrane spiculate; ninth tergum short and strongly tapered, with well developed, triangular, apicolateral processes. Basistyle with dorsal and ventral roots relatively short, the ventral root foot-shaped with long heel and sharp-pointed toe; dististyle with slender, bent apex. Aedeagus with broad, rounded basal arch, the basal arms slender and curved; distal stem short and rounded apically. Parameres each with basal knob, stem abruptly bent near base, slender and sinuate distad, without ventral lobe, apex sharp with two or three lateral barbs.

DISTRIBUTION: Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Clayton, Fort Davis, Fort San Lorenzo, Huile Sia Clara(?).

Loma Boracho, Madden Dam, Mojinga Swamp (type locality).

CHIRIQUÍ PROVINCE: Río Tabasará, Tortugas.

COCLÉ PROVINCE: Espiño.

COLÓN PROVINCE: Piña.

DARIÉN PROVINCE: Jaqué.

PANAMÁ PROVINCE: Camarón, Cerro Campana, Chepo, El Coco, La Jolla,

Pacora, Pedregal, Isla Taboga, Tocumen, Viqué Cove.

VERAGUAS PROVINCE: Río Santa María, Sapotilla.

DISCUSSION: Typical specimens of *galindoi* from Mojinga Swamp, Fort Sherman, and Loma Boracho have the pale distal spot in cell R_5 rounded distally, leaving a small dark area in apex of cell as figured in our 1953 paper. More common in Panama, however, is the form having the apex of cell R_5 entirely pale. Structurally, typical *galindoi* has the costal ratio longer (0.55), the antennal ratio greater (1.08), resembling *limai*, and the spermathecae more nearly equal in size. In the atypical *galindoi* (as well as in *tenuilobus*, new species) the antennal segments gradually increase in length to the seventh segment, then segment eight is shorter and the segments increase in length again, while in the typical specimens the segments gradually increase in length up to the tenth segment.

Culicoides limai is very closely related, having a wing pattern like the atypical specimens discussed in the paragraph above, but

limai can be readily distinguished by its smaller size, the subapical pale band on the hind femur and pale apex of the hind tibia, the much broader third palpal segment, and the presence of a small ventral lobe on the male parameres.

36. *Culicoides limai* Barretto

FIGURE 39

Culicoides limai Barretto, 1944, Anais Fac. Med. Univ. São Paulo, vol. 20, p. 99 (male; Est. São Paulo, Brazil; fig. genitalia, antenna, palpus, mesonotum, wing).—Ortiz and Mirsa, 1951, Rev. Sanid. Asist. Soc., vol. 16, p. 597 (male; Venezuela; fig. mesonotal pattern, palpus, spermatheca, wing, male genitalia); 1952, idem., vol. 17, p. 265 (female; Venezuela; fig. wing, antenna, palpus, spermathecae). Forattini; 1954, Fol. Clin. Biol., vol. 22, p. 224 (male, female; Brazil, Colombia; fig. wing, palpus, eyes, mesonotum, antenna,

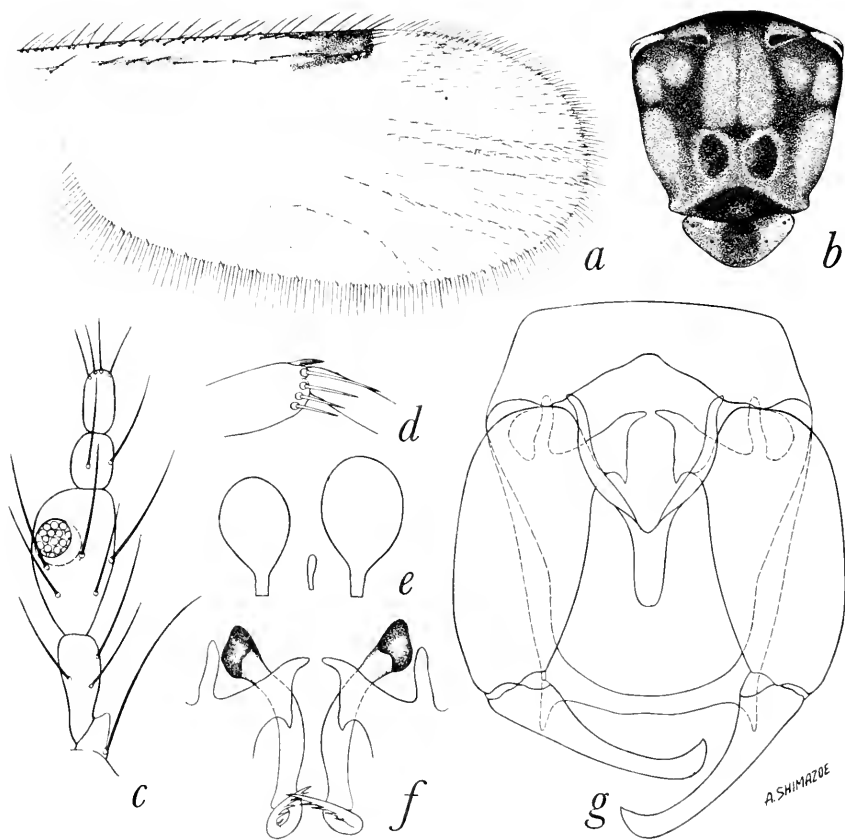


FIGURE 39.—*Culicoides limai* Barretto. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

male genitalia).—Ortiz and Leon, 1955, Inf. Cient. Nac. Ecuador, no. 67, p. 577 (Ecuador).

FEMALE: Length of wing 0.80 (0.79–0.82, $n=5$) mm.

Head.—Eyes nearly contiguous, bare. Antenna with flagellar segments in proportion of 15:10:11:12:13:13:13:13:17:18:19:20:32, antennal ratio 1.06; distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 8:15:20:6:7, third segment considerably swollen up to the apex, 1.8 (1.7–1.8, $n=5$) times as long as greatest breadth, with a moderately broad, shallow sensory pit. Mandible with 13 (12–14, $n=5$) teeth.

Thorax.—Mesonotum dark brown with extensive, pruinose, yellowish patches as figured, principally two elongate submedian anterior marks, two pairs of lateral spots and extensive prescutellar areas. Scutellum narrowly dark brown in middle, yellowish on sides; post-scutellum and pleuron dark brown. Legs dark brown, all femora with subapical, all tibiae with subbasal, and hind tibia with broad apical pale rings; hind tibial comb with four ($n=5$) spines, the one next to the spur longest.

Wing.—Pattern as figured, closely resembling that of *galindoi* but with the distal pale spot in cell R_5 shortened and rounded distally, and extending obliquely to the anterior wing margin, not following vein M_1 to the wing tip. Macrotrichia sparse on distal fourth of wing; costa extending to 0.63 of distance to wing tip. Halter pale.

Abdomen.—Brownish black; cerci yellowish. Spermathecae two, slightly unequal, pyriform, measuring 0.059 by 0.042 mm. and 0.055 by 0.046 mm.

MALE GENITALIA: Ninth sternum with shallow caudomedian excavation; ninth tergum tapering, with small, triangular apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root slender; dististyle slender, with bent apex. Aedeagus with rounded basal arch, the basal arms slender and curved, distal stem slender and tapering to bluntly rounded apex, the ventral side appearing channel-like. Parameres each with knobbed base, slender, bent stem with distinct ventral lobe, apical portion tapered to fine point with sub-lateral barbs.

DISTRIBUTION: Brazil; Ecuador; Honduras (Lancetilla); Panama; Trinidad (Tucker Valley); Venezuela.

PANAMA RECORDS:

CANAL ZONE: Fort Sherman, Mojinga Swamp.

PANAMÁ PROVINCE: Arraiján, Cerro Campana.

DISCUSSION: This widely distributed Neotropical species is rare in Panama. It is readily distinguished from the closely related Panama species, *galindoi* Wirth and Blanton, by the presence of the

subapical pale ring on the hind femur, the pale apex of the hind tibia, and the presence of a distinct ventral lobe on the male paramere.

37. *Culicoides tenuilobus*, new species

FIGURE 40

FEMALE: Length of wing 0.89 (0.86–0.92, $n=7$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 17:12:12:13:14:12:12:12:19:19:22:24:34, antennal ratio 1.13 (1.04–1.19, $n=4$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 8:13:27:8:7, third segment greatly swollen, 1.86 (1.76–1.93, $n=6$) times as long as greatest breadth, with a large deep sensory pit opening by a small pore. Mandible with 13 (12–13, $n=5$) teeth.

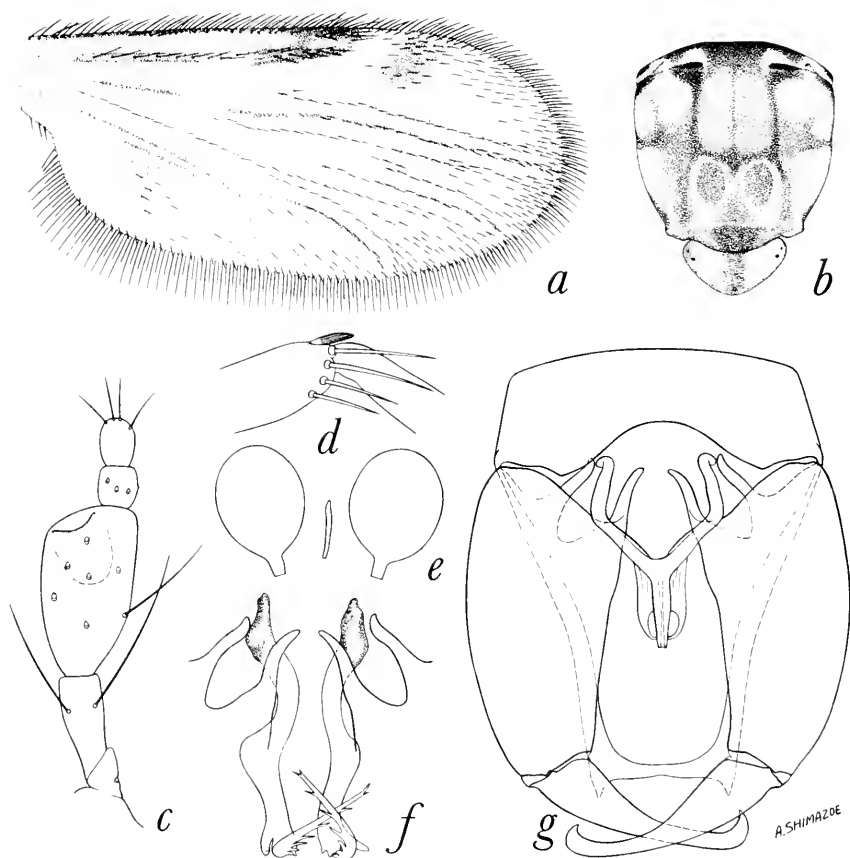


FIGURE 40.—*Culicoides tenuilobus*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum pruinose grayish brown with the anterior and lateral margins blackish; a moderately prominent pattern of narrow dark brown lines forming an H-shaped mark on the disc from the humeral pits to the sides of the scutellum. Scutellum dark brown in middle, yellowish on sides; postscutellum and pleuron dark brown. Legs dark brown, knee spots blackish; all femora with subapical, tibiae with subbasal and hind tibia with apical narrow pale rings; hind tibia with four ($n=6$) spines, the two nearest the spur longest, subequal.

Wing.—Pattern as figured; second radial cell in a moderately dark spot; pale spot over r-m crossvein continued in full breadth to costal margin; poststigmatic pale spot in cell R_5 double, the posterior portion slightly larger and located slightly proximad of the anterior portion; distal pale spot in cell R_5 suboval, broadly meeting anterior wing margin its full length, filling all but extreme caudodistal corner of cell; distal pale spot in cell M_1 elongate, broadly meeting wing margin; pale spot present straddling middle of vein M_2 ; pale spots in apices of cells M_2 and M_4 broadly meeting wing margin, the one in cell M_4 broadly rounded, nearly filling apex of cell; one pale spot, which may nearly meet wing margin as a posterior point, in distal portion of anal cell; a small pale spot in basal portion of anal cell; cell M_2 without pale spot lying in front of mediocubital fork, but a large pale spot lying behind medial fork and joined broadly to the pale spot over r-m crossvein. Macrotrichia sparse on distal half of wing and a few in anal cell; costa extending to 0.62 (0.60–0.64) of distance to wing tip. Halter dull yellowish.

Abdomen.—Brownish black. Spermathecae two, ovoid, subequal, measuring 0.056 by 0.036 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with a broad, moderately shallow, caudomedian excavation; ninth tergum very long and narrow distad, with short apicolateral processes. Basistyle with ventral and dorsal roots subequal, long and slender; dististyle very slender and bent at tip. Aedeagus with basal arch pointed at mesal apex, basal arms strong and curved; distal portion with well sclerotized slender median point flanked by a pair of sclerotized incurve processes nearly as long. Parameres each with large basal knob, stem sinuate and somewhat swollen beyond midlength and bearing a long, slender ventral lobe or process at the subapical bend; distal portion with sharp point and a lateral fringe of fine spines.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63166), Almirante, Bocas del Toro Province, Oct. 28, 1952, F. S. Blanton, light trap. Allotype male, same data except dates October–December 1952.

Paratypes, 6 males, 33 females: 4 males, 31 females, Almirante, October 1952 to March 1953; 1 male, Fort Sherman, Canal Zone, Sept. 28, 1953; 1 male, Mojinga Swamp, Canal Zone, February 1952; 2 females, Piña, Colón Province, Jan. 18, 1954.

DISCUSSION: This species is most closely related to *galindoi* Wirth and Blanton and *limai* Barretto, although vein M_2 is straddled by a pale spot, as in the species of the *copiosus*, *daedalus*, and *iriartei* groups. The wing markings are closest to those of *antefurcatus*, new species, which differs however in having only one pale spot in the anal cell, no pale spot in front of the mediocubital fork, and the hind femora with subapical pale rings. The ventral lobe of the male paramere is more extremely developed, into a rodlike process, in *tenuilobus* than in any species of *Culicoides* known to us.

38. *Culicoides camposi* Ortiz and Leon

FIGURE 41

Culicoides camposi Ortiz and Leon, 1955 (January–February), Bol. Inf. Cient. Nac. Ecuador, no. 67, p. 580 (female; Ecuador; fig. wing, mesonotum, palpus, antenna).

Culicoides fairchildi Wirth and Blanton, 1955 (October), Bull. Brooklyn Ent. Soc., vol. 50, p. 103 (male, female; Panama; fig. wing, palpus, spermathecae; male genitalia). New synonymy.

FEMALE: Length of wing 0.86 (0.79–0.96, $n=3$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:10:12:13:11:11:12:13:20:21:22:21:41, antennal ratio 1.18 (1.10–1.27, $n=2$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 6:13:17:10:8, third segment swollen, 2.1 times as long as greatest breadth, with a broad, shallow, irregular sensory pit. Mandible with 13–14 ($n=2$) teeth.

Thorax.—Mesonotum dark brown on anterior half with a prominent pattern of yellowish patches, consisting of a submedian pair of large elongate spots, just laterad of which is another pair of very small round spots; humeri, a small area around each sensory pit, and entire posterior half of mesonotum yellowish. Scutellum dark brown in middle and yellowish on sides; postscutellum dark brown; pleuron yellow on upper half and dark brown below. Legs dark brown; knee spots blackish; fore and mid femora with very broad subapical bands, all tibiae with very broad basal bands and broad apex of hind tibia, yellowish; hind tibial comb with four ($n=2$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell very dark; pale spot over r-m crossvein broadly reaching costal margin; poststigmatic pale spot in cell R_5 extended proximad behind second radial cell;

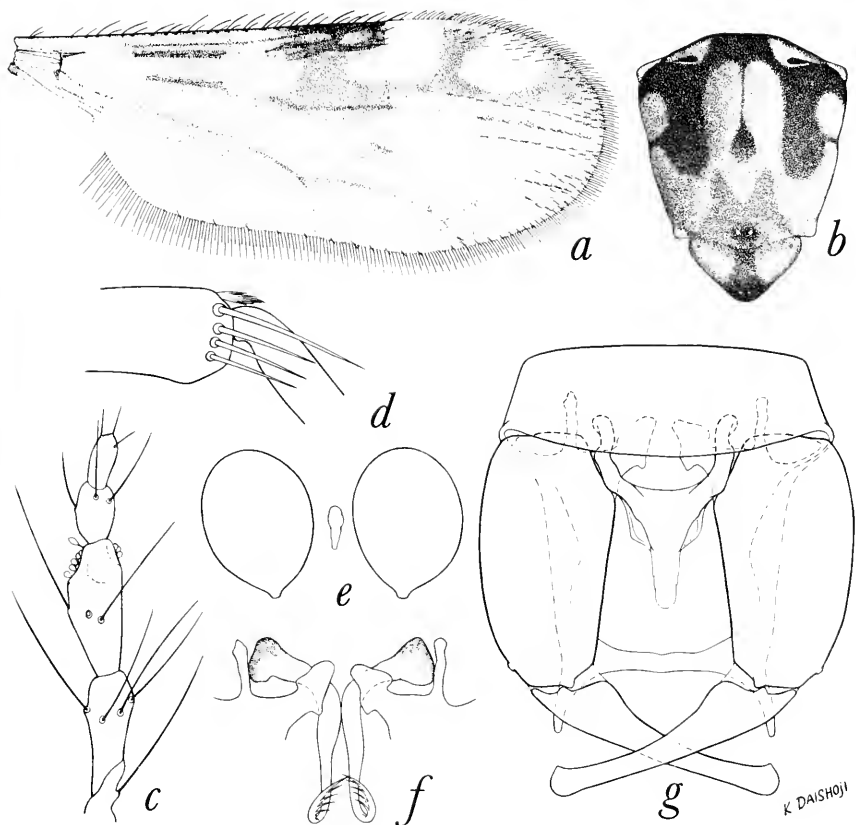


FIGURE 41.—*Culicoides camposi* Ortiz and Leon. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

distal pale spot in cell R_5 rounded, almost reaching anterior wing margin; a pale spot present in center of wing straddling middle of veins M_1 and M_2 and usually filling the intervening space in cell M_1 ; distal pale spot in cell M_1 elongate and nearly reaching wing margin; pale spots present at wing margin in apices of cells M_2 and M_4 ; two pale spots, which may be more or less fused, in distal part of anal cell; base of anal cell pale; cell M_2 with a small pale spot lying in front of mediocubital fork and a pale area extending from behind medial fork to base of wing. Macrotrichia sparse in apices of cells R_5 , M_1 and M_2 , none proximad; costa extending to 0.59 (0.58–0.60, $n=2$) of distance to wing tip. Halter yellowish.

Abdomen.—Blackish on sides, grayish pruinose above. Spermathecae two, pyriform, subequal, very small, each measuring 0.029 by 0.019 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum without caudomedian excavation; ninth tergum slightly tapering to long, slender, apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel poorly developed, dorsal root slender, as long as ventral root; dististyle long and slender, nearly straight, with capitate tip. Aedeagus with basal arch short, reaching to about a third of total length of aedeagus, basal arms curved and stout; distal portion slender with rounded tip. Parameres each with very large basal knob, stem bent near base, slender, midportion straight, without ventral lobe; distal portion with slightly expanded fringe of fine spines toward the sharp tip.

DISTRIBUTION: Ecuador; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort San Lorenzo, Madden Dam (type locality of *fairchildi*), Mojinga Swamp.

COLÓN PROVINCE: Cativá.

DARIÉN PROVINCE: El Real, Garachiné.

DISCUSSION: We have no doubt of the synonymy of *fairchildi* with *camposi*, since this is such a strikingly marked species. We had not seen Ortiz and Leon's paper describing *camposi* when we prepared our description.

This species is apparently related to *carpenteri* Wirth and Blanton and *galindoi* Wirth and Blanton, which have very similar male genitalia, although the very striking wing pattern of *camposi* with pale spots straddling the middles of veins M_1 and M_2 will readily separate it from those two species.

39. *Culicoides carpenteri* Wirth and Blanton

FIGURE 42

Culicoides carpenteri Wirth and Blanton, 1953, Journ. Washington Acad. Sci., vol. 43, p. 72 (male, female; Panama; fig. wing, mesonotum, palpus, male genitalia).

FEMALE: Length of wing 0.99 (0.96–1.02, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 20:14:15:15:15:14:15:15:26:27:33:31:43, antennal ratio 1.22 (1.17–1.30, $n=8$); distal sensory tufts present on segments III, XI–XIV. Palpal segments in proportion of 10:20:25:10:10, third segment scarcely swollen, 2.4 (2.2–2.7, $n=10$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 14 (13–14, $n=10$) teeth.

Thorax.—Mesonotum elongate, color yellowish brown, anterior portion except humeri darker brown and a narrow median line and a sublateral pair of broader longitudinal bands of brown extending caudad to about middle of mesonotum, or sometimes to scutellum:

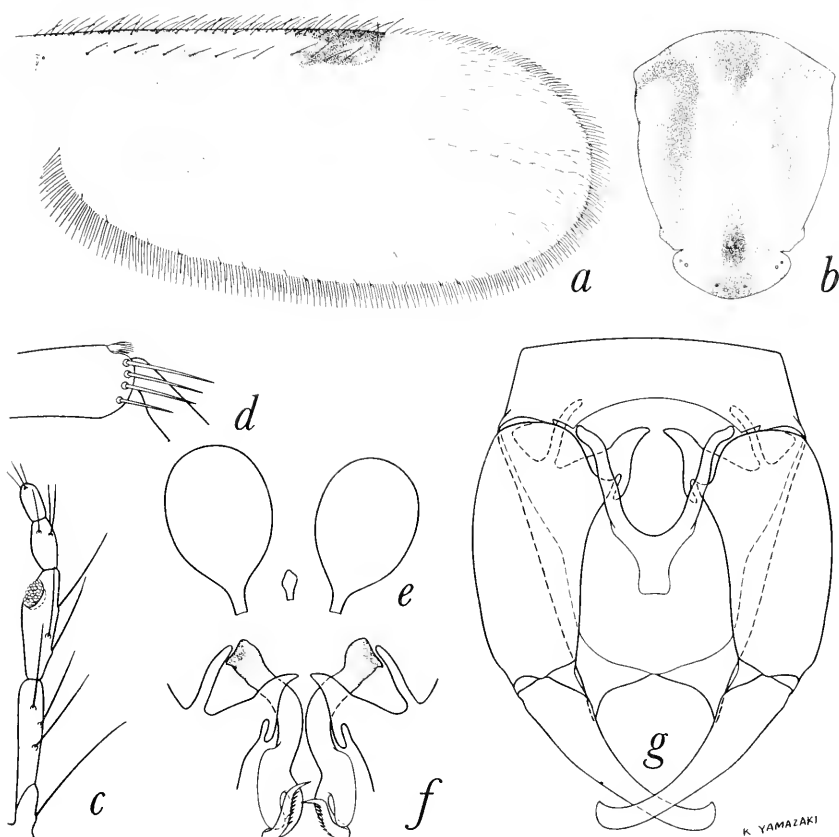


FIGURE 42.—*Culicoides carpenteri* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Scutellum dark in middle, sides yellowish; postscutellum and pleuron dark brown. Legs brown, all femora with basal and subapical, tibiae with subbasal, and hind tibia with apical wide pale bands; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale areas extensive but comparatively faint; second radial cell very dark; large pale area over r-m crossvein; poststigmatic pale area in cell R_5 extensive, extending from anterior wing margin around second radial cell and sometimes fusing with pale spot over crossvein; distal pale spot in cell R_5 extensive, broadly extending across cell near apex from anterior wing margin to vein M_1 ; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 dark; cell M_1 with a long basal area extending across veins M_1 and M_2 to fuse with poststigmatic pale spot in cell R_5 and subapical pale spot in cell M_2 , distal pale spot in cell M_1 broadly meeting wing margin; two pale spots in

distal part of cell M_2 , the distal one broadly meeting wing margin; the proximal one connected by a pale area extending to base of cell and including the pale spots lying in front of mediocubital fork and behind medial fork; pale area in cell M_4 nearly filling entire cell; anal cell pale except for a large dark area centering on middle of stem of medio-cubital vein. Macrotrichia very sparse, appearing only on distal fourth of wing in cells R_5 , M_1 and M_2 ; costa extending to 0.61 (0.59–0.62, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Light brown, whitish on basal half above. Spermathecae two, ovoid to slightly pyriform, slightly unequal, measuring 0.057 by 0.042 mm. and 0.046 by 0.031 mm., the bases of the ducts sclerotized for a considerable distance.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum markedly tapering, the large, triangular, apicolateral processes situated relatively close together. Basistyle with ventral root large and foot-shaped, dorsal root slender; dististyle long and slender with bent, pointed tip. Aedeagus with basal arch rounded, extending to two-thirds of total length, the basal arms well sclerotized and curved; the short distal portion broad with truncate apex. Parameres each with large basal knob, stem stout, abruptly bent a short distance from base, the midportion short and bearing a long ventral lobe, distal portion slender and abruptly bent and bearing a lateral fringe of fine spines before the pointed tip.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CANAL ZONE: Barro Colorado Island (January–March 1944, Zetek), Fort Davis, Fort Sherman, Gamboa, Huile Sia Clara (?), Loma Boracho, Madden Dam (type locality), Mandinga River, Mojinga Swamp.

PANAMÁ PROVINCE: El Coco, Pedregal.

VERAGUAS PROVINCE: Río Santa María.

DISCUSSION: By wing pattern, general appearance, and structure of the male genitalia, *carpenteri* appears to be related to *camposi* Ortiz and Leon, *galindoi* Wirth and Blanton, and *limai* Barretto, but the sensorial pattern, with sensoria present on segments III, XI–XIV, does not resemble that of any of these species, and the true relation of *carpenteri* thus remains obscure.

40. *Culicoides magnipalpis* Wirth and Blanton

FIGURE 43

Culicoides magnipalpis Wirth and Blanton, 1953, Journ. Washington Acad. Sci., vol. 43, p. 76 (male, female; Panama; fig. wing, antenna, spermathecae, male genitalia).

FEMALE: Length of wing 1.07 (1.06–1.09, $n=2$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 19:17:18:17:18:17:17:18:23:23:23:23:32,

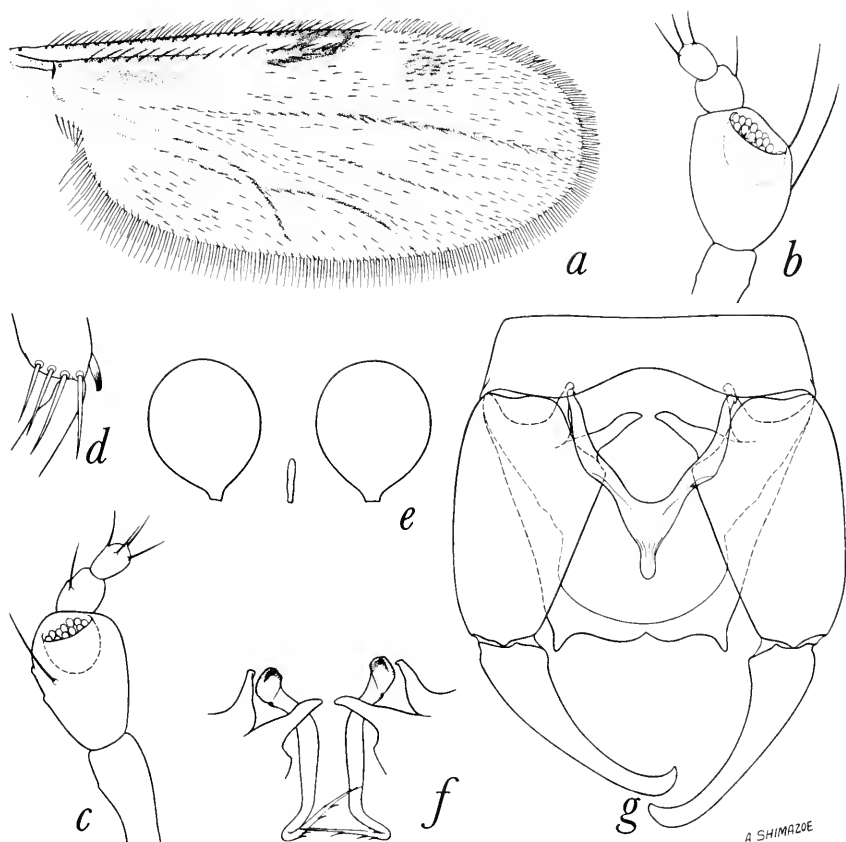


FIGURE 43.—*Culicoides magnipalpis* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

antennal ratio 0.91 (0.88–0.94, $n=2$); distal sensory tufts present on segments III, XI–xv. Palpal segments in proportion of 10:20:30:8:7, third segment remarkably bulbously swollen, 1.3 times as long as broad, with a broad, deep sensory pit on distal half. Mandible with 13 teeth.

Thorax.—Mesonotum tawny yellowish brown, a contiguous pair of faint, paler yellowish, oval, submedian, anterior spots on disc; humeral corners with a pair of small whitish spots; area between these spots and humeral pits blackish. Scutellum yellowish, darker in middle; postscutellum and pleuron blackish, pleuron pale on upper half. Legs brown; femora with subapical and tibiae with subbasal narrow pale rings; hind tibial comb with 4 ($n=2$) spines, the two nearest the comb subequal, longest.

Wing.—Pattern as figured; second radial cell moderately dark brown; pale spot over r-m crossvein small, broadly meeting anterior wing margin; poststigmatic pale spot in cell R_5 simple, transverse, extending across cell nearly to vein M_1 , the pale spot in distal part of cell elongate, lying parallel to wing margin, sometimes extending broadly to wing margin; two pale spots in cell M_1 , the distal one broadly meeting wing margin; one pale spot in distal part of cell M_2 , broadly meeting wing margin; pale spot in cell M_4 extending broadly from vein M_{3+4} to wing margin; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 dark at wing margin; anal cell with a single, more or less double pale spot across distal portion and a pale area along anal vein near base; cell M_2 with an elongate pale mark behind medial fork, dark in front of mediocubital fork. Macrotrichia numerous and long over entire wing to base of cell M_2 and anal cell; costa extending to 0.60 (0.59–0.61, $n=2$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, subequal, subspherical, collapsed in specimens available and not measured.

MALE GENITALIA: Ninth sternum with a broad, shallow caudo-median excavation; ninth tergum with apex broad, apicolateral processes slender and pointed. Basistyle with ventral root foot-shaped, the posterior heel poorly developed, ventral root slender; dististyle slender and curved with bent, pointed tip. Aedeagus with narrow, pointed basal arch, the basal arms slender and curved, distal portion tapered to slender point with indistinct subapical points. Parameres each with small basal knob, stem slender and slightly bent near base, straight in midportion and gradually tapering to ventrally curved, points with a subapical fringe of very fine spines.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Volcán.

PANAMÁ PROVINCE: Cerro Campana (type locality).

DISCUSSION: This species is provisionally placed in the *limai* group near *galindoi* Wirth and Blanton on the basis of wing pattern and male genitalic structure, but the sensorial pattern and very hairy wing would indicate possible affinities with the *daedalus* group.

The *acotylus* group

This is a heterogeneous group of species, placed here more for convenience than because of any definitely close relation. Moderate sized to large species with very prominent wing pattern of numerous round spots, cells R_5 and M_1 with pale spots in apices of cells or with poststigmatic pale spots clustering around a small dark spot behind second radial cell; r-m crossvein often dark; antenna with sensoria

always present on some of the proximal flagellar segments, absent on the last five except in *venezuelensis*; tibial comb with four or five spines; two spermathecae present; ventral root of male basistyle slender or foot-shaped; aedeagus often with stout basal arch and modified tip with well developed lateral points; parameres with or without ventral lobe or distal fringing spines.

PANAMA SPECIES: Six: *acotylus* Lutz, *carsiomelas* Wirth and Blanton, *guyanensis* Floch and Abonnenc, *lanei* Ortiz, *venezuelensis* Ortiz and Mirsa, and *wokei* Fox.

41. *Culicoides wokei* Fox

FIGURE 44

Culicoides wokei Fox, 1947, Kuba, vol. 3, p. 90 (female; Panama; fig. wing, palpus).
Culicoides aethionotus Wirth and Blanton, 1955, Bull. Brooklyn Ent. Soc., vol. 50, p. 121 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia). New synonymy.

FEMALE: Length of wing 0.78 (0.75–0.84, $n=9$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 17:13:13:13:13:13:13:13:16:17:18:20:30, antennal ratio 0.95 (0.93–0.96, $n=2$); distal sensory tufts present on segments III to X. Palpal segments in proportion of 8:16:20:8:10, third segment short and swollen, 1.6 (1.5–1.7, $n=8$) times as long as greatest breadth, with broad, shallow sensory pit. Mandible with 14 (13–15, $n=7$) teeth.

Thorax.—Mesonotum dull, blackish brown on humeri, broadly on each side of sensory pits and narrowly along sides to wing bases, disc uniformly dark grayish to coppery pruinose. Scutellum uniformly pruinose brown; postscutellum and pleuron blackish. Legs dark brown, all femora pale at bases; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=5$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale spots whitish and extensive, in a framework of narrow, connected dark linear markings, principally along the veins; second radial cell dark; pale spot over r-m crossvein very broad, a large pale area over base of wing, the dark area between these pale areas quite short; cell R_5 with three pale spots, a small one at end of second radial cell, an elongate one behind second radial cell sometimes narrowly meeting the pale spot over crossvein and the anterior poststigmatic pale spot, and the third pale spot extensive, nearly filling apex of cell R_5 , broadly meeting anterior wing margin and continuing along the margin as a narrow pale appendage nearly to end of cell M_1 ; two elongate, pale, streak-like spots in cell M_1 , the distal one broadly meeting wing margin; two pale spots in distal part of cell M_2 , the distal one broadly meeting wing margin; pale spot in

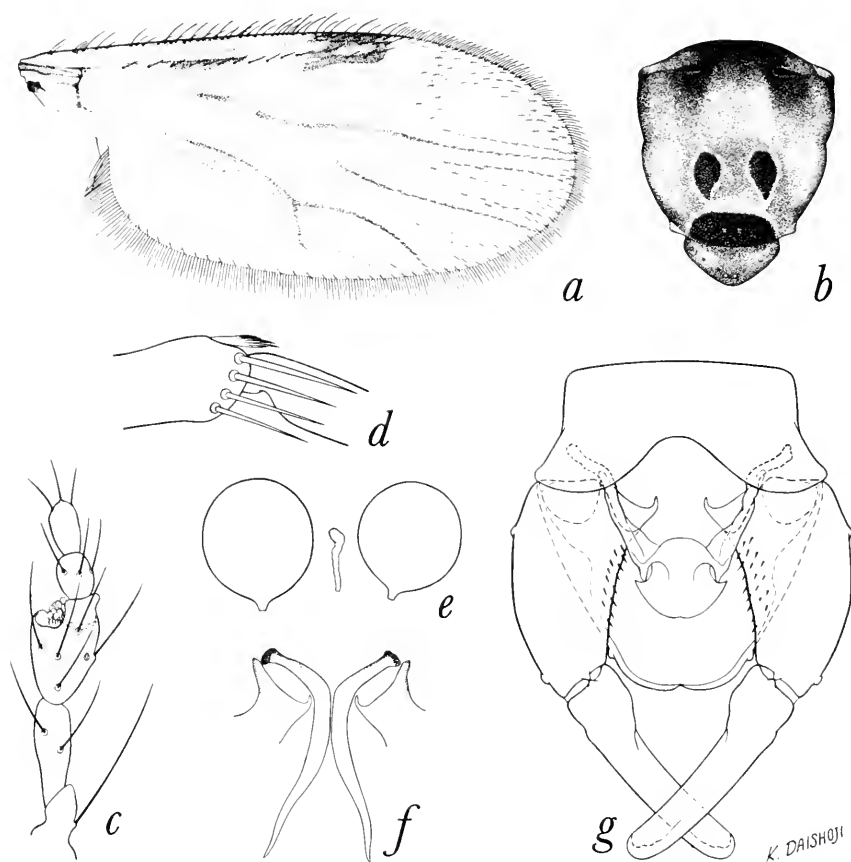


FIGURE 44.—*Culicoides woeki* Fox. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

cell M_4 continued in full breadth across cell from vein M_{3+4} to wing margin, one pale spot in distal part of anal cell; Cell M_2 with a small pale spot lying in front of mediocubital fork and one lying behind medial fork. Macrotrichia sparse on distal third of wing; costa extending to 0.61 (0.60–0.64, $n=9$) of distance to wing tip. Halter pale.

Abdomen.—Dull brownish black. Spermathecae two, large and heavily sclerotized, slightly ovoid, slightly unequal, measuring 0.062 by 0.047 mm. and 0.051 by 0.043 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with moderately deep caudo-median excavation; ninth tergum rounded caudal, the apicolateral processes not developed. Basistyle short and broad with mesal mar-

gin densely setose, ventral and dorsal roots short and pointed, slender, subequal in length, and joined together by a dark sclerotization; dististyle longer than basistyle, moderately stout and straight, with blunt apex. Aedeagus with a broad basal arch extending to two-thirds of total length, the basal arms nearly straight; distal portion very broad and heavily sclerotized with the apex in the form of a mushroom-shaped cap. Parameres each with long, heavily sclerotized, rodlike, laterally directed basal processes, abruptly bent at the base of the stem which is somewhat swollen at the base of the straight midportion and gradually narrowed and only slightly curved to a slender simple tip.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CANAL ZONE: Balboa (West Bank, June 26, 1942, P. A. Woke 1021, at light; holotype of *wokei* Fox), Galeta Point, Loma Boracho, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Alanje, Chiriquí.

COCLÉ PROVINCE: Puerto Farallón, Río Hato.

DARIÉN PROVINCE: Garachiné, Jaqué, Punta Patiño (type locality of *aethionotus*).

HERRERA PROVINCE: Puerto Chitré.

PANAMÁ PROVINCE: Bayano, Chepo, Pedregal, San Carlos, Isla Taboga.

ARCHIPIÉLAGO DE LAS PERLAS: Isla del Rey.

DISCUSSION: We are sinking *aethionotus* in the synonymy under *wokei* as the result of a direct comparison of the respective holotypes, that of *wokei* having kindly been loaned to us by Dr. Irving Fox.

The wing pattern of *wokei* is very similar to that of *galindoi* and *limai*, but the antennal sensorial pattern and structure of the male genitalia make it seem likely that *wokei* is more closely related to the species of the *acotylus* group.

42. *Culicoides carsiomelas* Wirth and Blanton

FIGURE 45

Culicoides carsiomelas Wirth and Blanton, 1955, Bull. Brooklyn Ent. Soc., vol. 50, p. 100 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 0.99 (0.96–1.02, $n=6$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 19:14:14:15:16:16:15:15:20:21:23:23:32, antennal ratio 0.96; distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 10:19:22:7; 8, third segment broadly swollen, 1.8 (1.6–2.0, $n=5$) times as long as greatest breadth, with a large, very deep, sensory pit. Mandible with 13 (12–14, $n=5$) teeth.

Thorax.—Mesonotum without prominent pattern, the sides and entire anterior margin to sensory pits dark brown; median area from

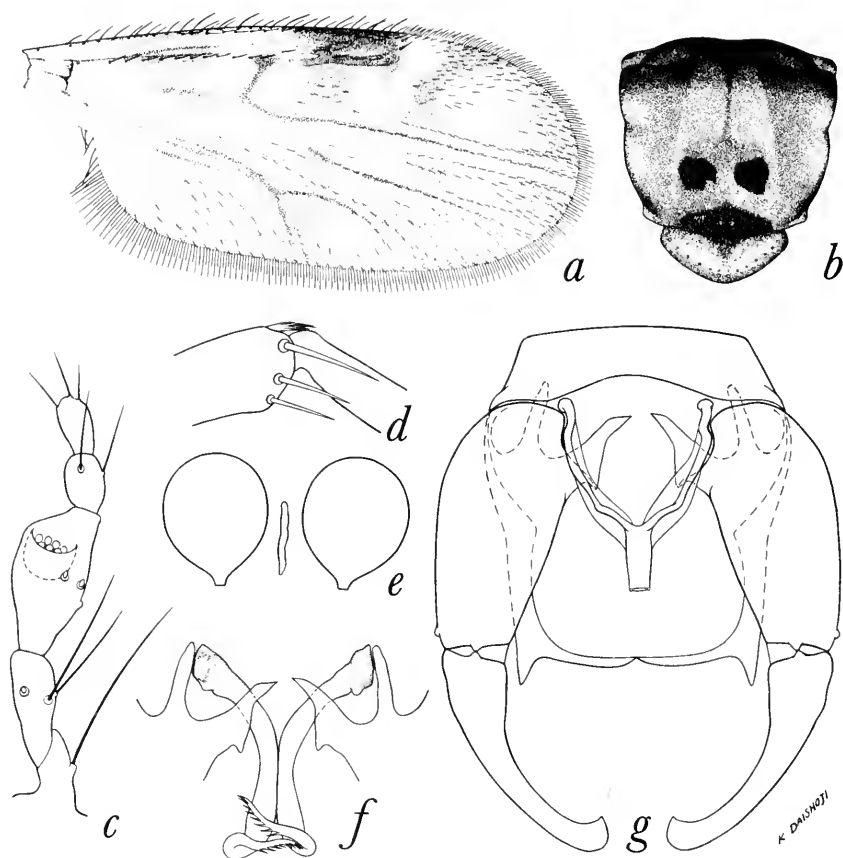


FIGURE 45.—*Culicoides carsiomelas* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

pits to prescutellar depression and wing bases brownish yellow. Scutellum yellowish, brown in middle on anterior margin; postscutellum and pleuron brownish black. Legs brown, fore and mid femora with subapical, all tibia with subbasal and hind tibia with apical narrow pale rings; hind tibial comb with four (3-5, $n=6$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell moderately dark, very broad, subequal in length to the first; r-m crossvein infuscated, lying in a broad pale spot which broadly reaches costal margin; cell R_5 with three pale spots, the proximal one a flattened U-shaped spot lying behind second radial cell, second spot lying on anterior wing margin just distad of end of costa, third spot occupying middle of distal part of cell, sometimes attaining anterior wing margin; apices

of veins M_1 , M_2 and M_{3+4} with small pale spots at wing margin; cell M_1 with two elongate pale spots, the distal one lying far from wing margin; two pale spots in distal part of cell M_2 , the distal one not reaching wing margin; a small pale spot present in center of cell M_4 ; distal portion of anal cell with one small round pale spot; cell M_2 with a small pale spot lying in front of mediocubital fork and one lying behind medial fork; base of wing broadly pale. Macrotrichia sparse but scattered over wing, including anal cell and base of cell M_2 ; costa extending to 0.65 (0.64–0.67, $n=6$) of distance to wing tip. Halter knob infuscated.

Abdomen.—Dull blackish, cerci yellowish. Spermathecae two, large, unequal, pyriform, measuring 0.061 by 0.043 mm. and 0.040 by 0.029 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with a very shallow caudomedian excavation; ninth tergum broad apically with short, pointed apico-lateral processes. Basistyle with ventral root foot-shaped, dorsal root long and slender; dististyle slender with narrow, curved apex. Aedeagus with broad, pointed basal arch extending to three-fourths of total length, the basal arms curved and stout; distal apex slender with truncated tip. Parameres each with large basal knob, stem slightly curved basally, straight and fairly stout on midportion with a well-developed ventral lobe, distal portion slender with fine lateral spines.

DISTRIBUTION: Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort San Lorenzo, Fort Sherman, Mojinga Swamp (type locality).

DARIÉN PROVINCE: El Real.

DISCUSSION: This species bears a close superficial resemblance to *acotylus* Lutz, with its infuscated crossvein, unmarked brownish mesonotum and general wing pattern. However, *acotylus* can be readily distinguished by the presence of two pale spots in the distal part of the anal cell, by the presence of five rather than three pale spots in cell R_5 , by the presence of only one pale spot in the apex of cell M_2 , and by the absence of a palpal pit.

43. *Culicoides acotylus* Lutz

FIGURE 46

Culicoides acotylus Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 69 (female; Rio Tapajos, Mato Grosso, Brazil; fig. wing, palpus).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 10 (Mato Grosso, Brazil).—Ortiz, 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 257 (female; Falcón and Guarica, Venezuela; fig. palpus, spermathecae, wing; synonym, *panamericanus* Fox). *Culicoides panamericanus* Fox, 1947, Kuba vol. 3, p. 90 (female; Mexico; fig. wing, palpus).

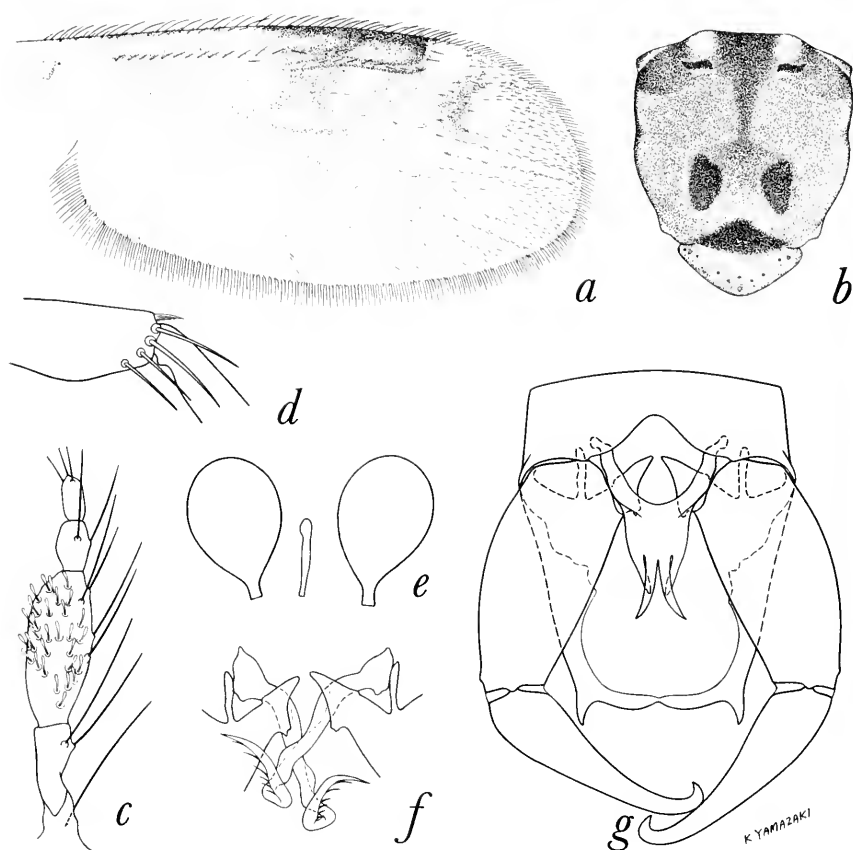


FIGURE 46.—*Culicoides acotylus* Lutz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

FEMALE: Length of wing 1.05 (0.96–1.11, $n=9$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 24:19:19:20:20:20:20:20:22:22:22:22:37, antennal ratio 0.78 (0.74–0.80, $n=4$); distal sensory tufts present on segments III and from VI or VII to X. Palpal segments in proportion of 10:16:32:10:9, third segment moderately swollen, 2.3 (2.1–2.8, $n=9$) times as long as greatest breadth, without sensory pit, the sensoria scattered on surface of segment. Mandible with 15 (14–15, $n=7$) teeth.

Thorax.—Mesonotum and scutellum dark brown, without prominent pattern, in some specimens paler brown in midportion. Postscutellum and pleuron brownish black. Legs dark brown, narrow pale rings at bases of all tibiae and at apex of hind pair; hind tibial comb with five (4–5, $n=7$) spines, the second from the spur longest.

Wing.—Pattern as figured; second radial cell very dark; radial cells broad, the second very broad, the first about twice as long as the second; r-m crossvein blackish, in the center of a large pale spot which broadly reaches costal margin; cell R_5 with five definite pale spots, one resting on anterior side of vein M_1 near base of cell, the next three arranged in an arc behind and around the apex of second radial cell and the fifth spot lying in middle of distal portion of cell R_5 , not reaching wing margin; two pale spots in cell M_1 , the distal one lying far from wing margin; apices of veins M_1 and M_2 pale margined a short distance; one pale spot each in apex of cell M_2 and cell M_4 , neither attaining wing margin; two pale spots in distal portion of anal cell and two in basal portion of this cell; cell M_2 with a pale spot lying in front of mediocubital fork, one lying behind medial fork and another lying across cell about halfway from these spots and wing base. Macrotrichia sparse on distal third of wing; costa extending to 0.70 (0.69–0.72, $n=8$) of distance to wing tip. Halter pale.

Abdomen.—Brownish black, cerci whitish. Spermathecae two, pyriform, slightly unequal, measuring 0.063 by 0.043 mm. and 0.059 by 0.042 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with a shallow caudomedian excavation; ninth tergum quadrate, with large, triangular apicolateral processes. Basistyle with ventral root large, foot-shaped; ventral root slender; dististyle long and slightly curved with pointed, bent tip. Aedeagus with rounded basal arch extending to a third of total length, the basal arms stout and curved; distal portion with four long, tapering pointed branches, the median pair cleft about half the distance from their apices to the arch, the lateral pair arising nearer to arch. Parameres each with very large basal knob, stem curved near base, only slightly swollen on curved portion, midportion of stem slightly sinuate, slender, without ventral lobe, the distal apex with a lateral fringe of long spines.

DISTRIBUTION: Brazil; Mexico; Panama; Venezuela.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Fort San Lorenzo, Fort Sherman, Loma Boracho, Mojinga Swamp.

DARIÉN PROVINCE: El Real, Jaqué.

PANAMÁ PROVINCE: Arraiján, La Jolla.

DISCUSSION: *Culicoides carsiomelas* Wirth and Blanton resembles *acotylus* in having an unmarked brownish mesonotum, darkened crossvein and the same general wing pattern, but can be readily distinguished by the presence of only one pale spot in the distal part of the anal cell, by the presence of two distal pale spots in cell M_2 , and the presence of five rather than three pale spots in cell R_5 .

44. *Culicoides guyanensis* Floch and Abonnenc

FIGURE 47

Culicoides guyanensis Floch and Abonnenc, 1942, Inst. Pasteur Guyane Terr. l'Inini, no. 37, p. 5 (male, female; Cayenne, French Guiana; fig. male, female wings, antenna, palpus, male genitalia).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 19 (Panama, Trinidad, Brazil; fig. male genitalia; synonyms, *recifensis* Barbosa, *stubaensis* Fox).

Culicoides stellifer Macfie (not Coquillett, misident.), 1937, Ann. Mag. Nat. Hist., vol. 20, p. 12 (female; Trinidad).

Culicoides recifensis Barbosa, 1943, Rev. Bras. Biol., vol. 3, p. 261 (female; Brazil; fig. wing).

Culicoides stubaensis Fox, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 254 (female; Trinidad; fig. wing, mesonotum).

FEMALE: Length of wing 0.99 mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:14:14:15:15:15:15:20:20:22:25:34, antennal ratio 1.0 (0.99–1.1, $n=2$); distal sensory tufts present on segments III, VI–X. Palpal segments in proportion of 9:23:27:10:13, third segment moderately swollen, 2.4 (2.1–2.6, $n=3$) times as long as greatest breadth, with a broad, shallow sensory pit. Mandible with 15 teeth.

Thorax.—Mesonotum densely pruinose gray, with a prominent pattern consisting mainly of a sublateral pair of broad brownish bands; a median area on anterior margin between humeral pits blackish. Scutellum narrowly brown in middle, yellowish on sides; postscutellum and pleuron dark brown. Legs brown; femora with bases broadly pale; all femora with subapical, tibiae with subbasal and hind tibia with apical narrow pale rings; hind tibial comb with four spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell very dark; yellowish area over r-m crossvein extending broadly to costal margin; cell R_5 with five small round, separate, pale spots spread from base to apex of cell; apices of veins M_1 , M_2 and M_{3-4} with a small pale spot at wing margin; three pale spots in cell M_1 , the distal one meeting wing margin; two pale spots in distal part of cell M_2 , the distal one meeting wing margin; pale spot in cell M_4 broadly meeting wing margin; one small round pale spot in distal portion of anal cell and a large pale area anteriorly at base of cell; cell M_2 with a pale spot behind medial fork and one at half the length of the mediocubital stem; pale spot just distad of basal arculus. Macrotrichia fairly numerous on distal half of wing and a few in anal cell; costa extending to 0.58 of distance to wing tip. Halter with base of knob brownish.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, pyriform, subequal, measuring 0.050 by 0.034 mm. and 0.050 by 0.029 mm., the bases of the ducts sclerotized a considerable distance.

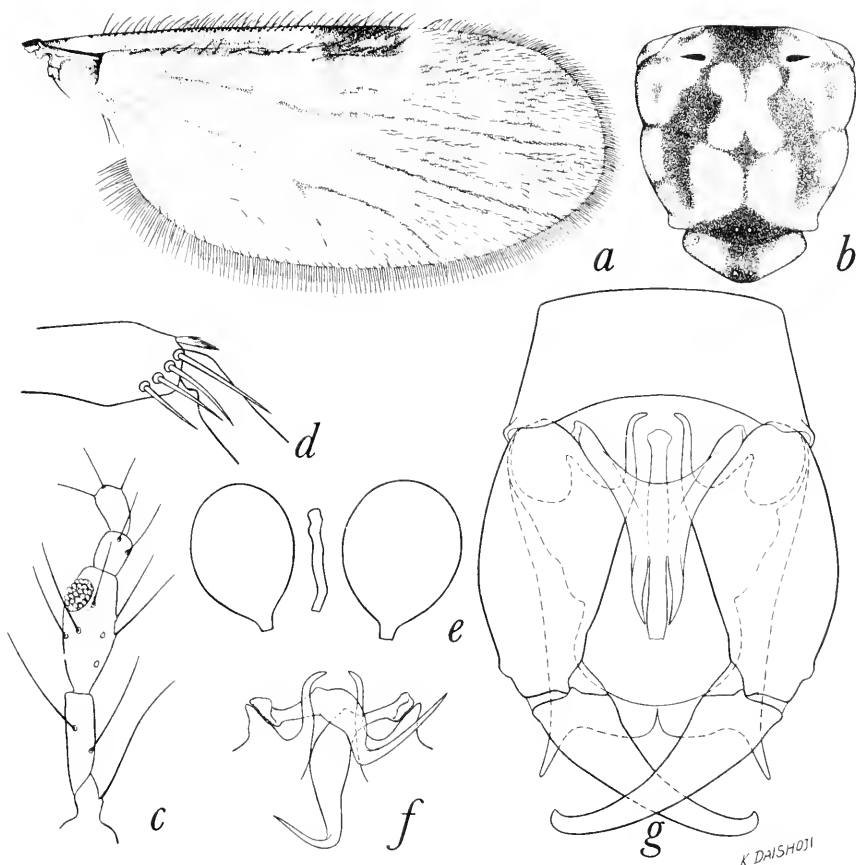


FIGURE 47.—*Culicoides guyanensis* Floch and Abonnenc. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

MALE GENITALIA: Ninth sternum remarkably long, without appreciable caudomedian excavation; ninth tergum quadrate, with slender, pointed, apicolateral processes. Basistyle with ventral root long and slender, dorsal root shorter and stouter; dististyle tapered to slender pointed tip. Aedeagus remarkably modified: basal arch broad and round, extending to half of total length, the basal arms curved and strongly sclerotized; distal portion with the long, slender median lobe detached at the base, its base curving dorsad of the arch and its proximal end lying free a short way between basal arms; a pair of slender, pointed, lateral lobes nearly as long as median lobe arising from basal arch on each side of median lobe. Parameres separate, each with basal lobe bearing a slender anterior process;

stem stout and curving on basal portion, gradually tapering distad to a slender simple point curving ventromesally.

DISTRIBUTION: French Guiana; Brazil; Panama; Trinidad.

PANAMA RECORDS:

CANAL ZONE: Balboa (June 23, Sept. 4, 1942, P. A. Woke), Empire (A. H. Jennings, coll.), Fort San Lorenzo, Fort Sherman, France Field, Loma Boracho, Mindi Dairy, Mojinga Swamp.

PANAMÁ PROVINCE: Arraiján, Bayano.

DISCUSSION: This species is not closely related to any other known species, but somewhat resembles *furens* (Poey) and *lanei* Ortiz in wing pattern. The remarkable structure of the male aedeagus is distinctive and suggests relations with the species *phlebotomus* (Williston) and *willistoni* Wirth and Blanton of the subgenus *Culicoides* (*Macfiella*).

45. *Culicoides venezuelensis* Ortiz and Mirsa

FIGURE 48

Culicoides venezuelensis Ortiz and Mirsa, 1950, Arch. Venez. Pat. Trop. Parasit. Med., vol. 2, p. 137 (male, female; Venezuela; fig. wing, palpus, antenna, spermathecae, male genitalia).—Wirth, 1955, Rev. Chilena Ent., vol. 4, p. 234 (synonyms, *pictipennis* (Philippi) 1865 preoccupied, and *ortizi* Fox).

Psychophaena pictipennis Philippi, 1865, Verh. Zool.-Bot. Ges. Wien, vol. 15, p. 628 (Chile; female; fig. wing). Preoccupied in *Culicoides* by *pictipennis* (Staeger) 1839.

Culicoides ortizi Fox, 1952, Ann. Ent. Soc. Amer., vol. 45, p. 366 (female; Venezuela; fig. wing, palpus, antenna, tibial comb, spermathecae).

FEMALE: Length of wing 1.37 (1.29–1.48, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 20:15:15:15:16:16:16:16:26:26:28:30:37, antennal ratio 1.19 (1.13–1.26, $n=4$); distal sensory tufts present on segments III, XI–XIV always, and also variably on segments V to X. Palpal segments in proportion of 11:22:36:8:15, third segment moderately swollen, 2.1 (1.9–2.2, $n=10$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 13 (13–14, $n=9$) teeth.

Thorax.—Mesonotum densely grayish pruinose, with a prominent pattern of numerous punctiform brown dots at the seta bases, those in midline and on sublateral rows more or less coalescing to form indistinct vittae. Scutellum pruinose gray, narrowly brown in middle and on extreme sides; postscutellum dark brown with pruinose gray patches, pleuron dark brown. Legs dark brown; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical narrow pale rings; hind tibial comb with five ($n=9$) spines, the second from the spur longest.

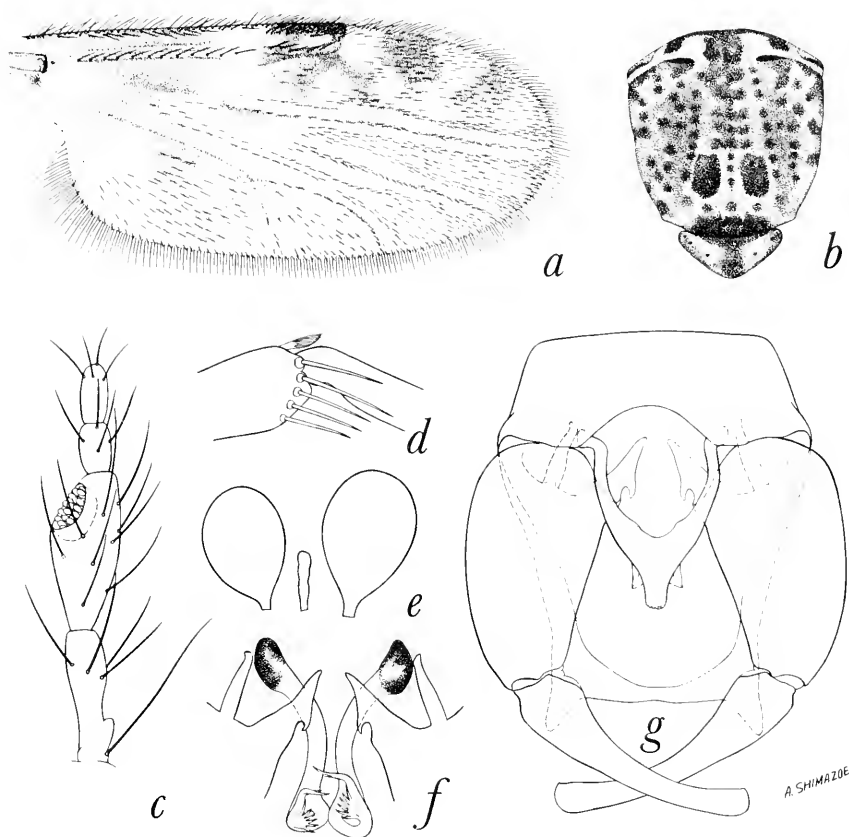


FIGURE 48.—*Culicoides venezuelensis* Ortiz and Mirsa. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Wing.—Pattern as figured; anterior margin of wing, including second radial cell, very dark; pale spot over r-m crossvein; cell R_5 pale at base next to r-m crossvein, distally with six small round pale spots arranged in two triangular groups of three each, the proximal group at level of end of costa, the distal group near apex of cell; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 with small pale spots at wing margin; three pale spots in cell M_1 , the proximal one with a pale extension across middle of vein M_2 and joining with the subapical pale spot in cell M_2 ; the distal spot in cell M_1 not reaching wing margin; two pale spots in distal portion of cell M_2 , the distal one separate from wing margin; round pale spot present in center of cell M_4 ; anal cell with two round pale spots in distal portion, two irregular pale areas at base, a faint pale streak in cell M_2 in front of medio-

cubital fork, two separate small pale spots behind base of medial fork and a proximal small pale spot lying in front of middle of mediocubital stem; base of wing with a pale spot. Macrotrichia fairly numerous over wing, including all of anal cell but not extending into proximal half of cell M_2 ; costa extending to 0.58 (0.56–0.59, $n=10$) of distance to wing tip. Halter whitish, the base of the knob dark.

Abdomen.—Brownish black; cerci yellowish. Spermathecae two, pyriform, slightly unequal, measuring 0.064 by 0.044 mm. and 0.057 by 0.038 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with a moderately narrow, deep, caudomedian excavation; ninth tergum broad apically, with short, triangular apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root slender; dististyle slightly curved with fairly blunt tip. Aedeagus with narrow, pointed basal arch extending to 0.8 of total length, the basal arms stout and nearly straight with flaring bases, a sclerotized membrane extending across distal fifth of arch; distal portion short, with truncated apex. Parameres each with large basal knob, stem moderately stout and slightly sinuate, bearing a short ventral lobe distally, the distal portion slender and bearing a lateral fringe of 4–5 spines well back from the pointed, simple tip.

DISTRIBUTION: Venezuela; Chile; Panama; Trinidad (Port Delgada).

PANAMA RECORDS:

CHIRIQUÍ PROVINCE: Volcán.

DISCUSSION: The synonymy of *venezuelensis* was published by Wirth (1955) after a comparison of the type of *pictipennis* (Philippi) from Santiago, Chile, with paratype material of *venezuelensis* from Venezuela.

46. *Culicoides lanei* Ortiz

FIGURE 49

Culicoides lanei Ortiz, 1950, Rev. Sanid. Asist. Soc., vol. 15, p. 431 (male; Cerro Sefa, Panama; fig. wing, mesonotum, palpus, genitalia); 1951, idem., vol. 16, p. 577 (notes; fig. wing, mesonotum, palpus, genitalia of male).

FEMALE: Length of wing 1.02 (0.96–1.12, $n=7$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 21:17:20:20:20:20:20:21:19:21:20:20:33, antennal ratio 0.72; distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 10:15:23:9:10, third segment moderately swollen, 1.8 (1.6–2.1, $n=6$) times as long as greatest breadth, with a small, deep, sensory pit. Mandible with 13 (12–14), $n=4$) teeth.

Thorax.—Mesonotum dark brown, with a prominent pattern of round or oval, yellowish gray pruinose patches as figured. Scutellum

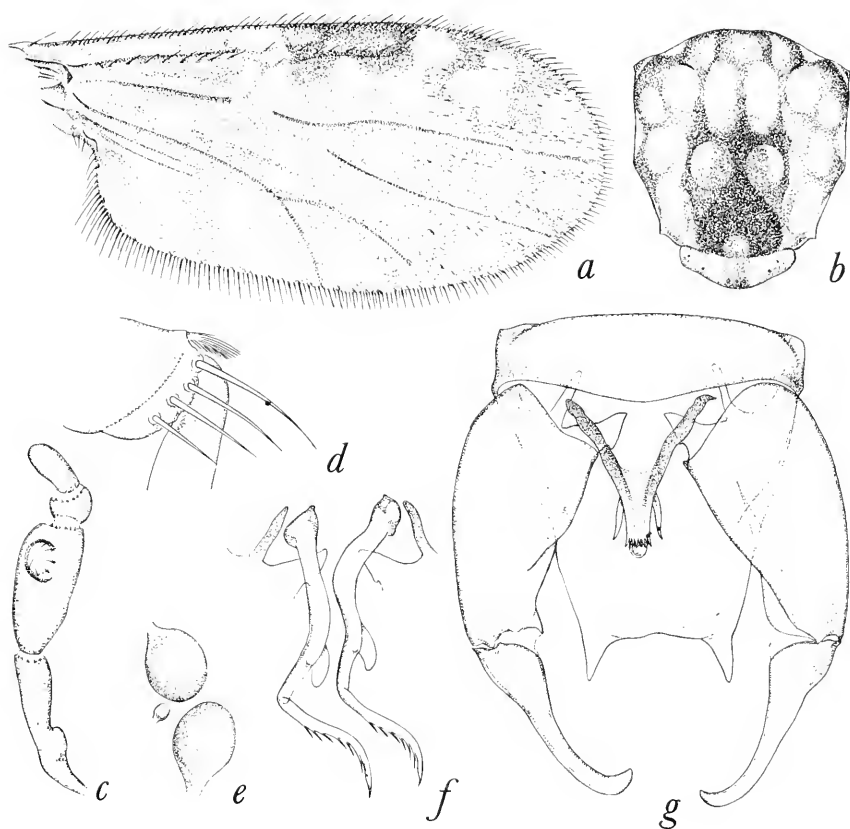


FIGURE 49.—*Culoicoides lanei* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

narrowly dark brown in middle, yellowish on sides; postscutellum and pleuron dark brown. Legs dark brown, fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=7$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell dark brown, more than twice as long as broad; pale spot over r-m crossvein narrow; cell R_5 with five definite pale spots; a small round one at end of costa and two, usually more or less confluent, in a longitudinal line behind second radial cell, these three more or less delimiting a small dark spot behind second radial cell; subapical pale spot in cell R_5 of irregular shape, usually with a narrow anterior connection to wing margin; a small round pale spot in apex of cell R_5 ; nearly all of vein M_1 and distal half of veins M_2 and M_{3+4} pale margined; three pale spots in cell M_1 , the distal one nearly reaching wing margin; cell M_2 with two pale spots in distal portion, the apical one nearly touching

wing margin; cell M_4 with a round pale spot in center; anal cell with two round pale spots in distal portion and an irregular pale area at base; cell M_2 with a double pale spot between medial and medio-cubital forks, with a pale line connecting it to the subapical pale spot in cell and to another pale spot in basal third of cell. Macrotrichia sparse on distal third of wing, none in anal cell; costa extending to 0.66 (0.63–0.68, $n=7$) of distance to wing tip. Halter with base of knob infuscated.

Abdomen.—Blackish. Spermathecae two, pyriform, subequal, each measuring 0.050 by 0.035 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with very small caudomedian excavation; ninth tergum tapering, the apicolateral processes long and triangular. Basistyle with ventral root foot-shaped, the posterior heel poorly developed, dorsal root slender; dististyle slender and curved to pointed tip. Aedeagus with basal arch extending to half of total length, the basal arms stout and nearly straight; distal portion tapering to a slender, striated tip with sclerotized subapical points well developed. Parameres each with large basal knob, stem moderately stout and slightly curved on basal and mid portions, with a large, bladelike, ventral lobe; distal portion long and slender with a lateral fringe of fine spines.

DISTRIBUTION: Panama; Honduras (Lancetilla); Trinidad.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort San Lorenzo, Fort Sherman, Gamboa, Loma Boracho, Mojinga Swamp.

DISCUSSION: Ortiz described this species from a male specimen collected by Fairchild at Cerro Sefa, Panama, 2,300 feet elevation, and sent to John Lane at the University of São Paulo, Brazil, where the type is now deposited.

The *reticulatus* group

This group consists mostly of medium-sized species, the wings usually with extensive pale markings, either veins M_1 and M_2 pale margined or pale spots at ends of veins (except in *macrostigma*); many species with a basic pattern of four pale spots in cell R_5 with the proximal three forming a ring around the second radial cell leaving a small dark spot just behind this cell; female antenna with sensoria present on segments III, and VI, VII or VIII to X; four tibial spines; two spermathecae; male genitalia with ventral root foot-shaped (except in *macrostigma*); paramere with simple basal knob, the stem very long and slender without ventral lobe, the apex simple or fringed; aedeagus with arch high and pointed, subapical points usually present.

PANAMA SPECIES: Eight or nine: *azureus*, new species; *dicrourus* Wirth and Blanton, *lyrinotatus* Wirth and Blanton; *mojingaensis* Wirth and Blanton; *parucienfuscatus* Barbosa; *pifanoi* Ortiz; *reticulatus* Lutz; and *volcanensis*, new species. *Macrostigma* Wirth and Blanton is provisionally referred here but its position is doubtful.

47. *Culicoides azureus*, new species

FIGURE 50

FEMALE: Length of wing 1.04 (1.02–1.09, $n=4$) mm.

Head.—Eyes contiguous a short distance, bare. Antenna with flagellar segments in proportion of 17:13:14:14:14:15:15:16:24:24:25:24:38, antennal ratio 1.18 (1.15–1.21, $n=2$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of

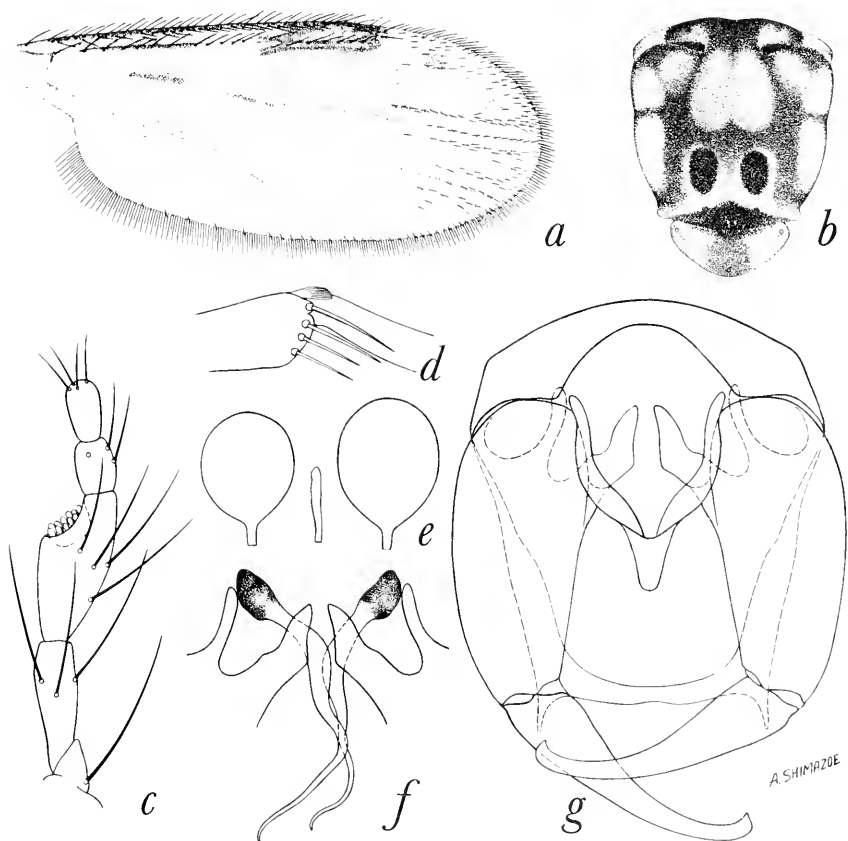


FIGURE 50.—*Culicoides azureus*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

8:16:23:9:9, third segment moderately swollen, 2.18 (2.09–2.27, $n=2$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 14–15 ($n=2$) teeth.

Thorax.—Mesonotum a rich, dark, brownish black with a prominent pattern of bluish gray patches, consisting mainly of a submedian, anterior, elongate pair and three lateral pairs of irregularly rounded, smaller spots. Scutellum brownish black in middle, grayish pruinose on sides; postscutellum and pleuron brownish black. Legs dark brownish black, femora with subapical and tibiae with subbasal, narrow pale rings; hind tibial comb with four ($n=5$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell moderately dark, markedly elongated; pale spot over r-m crossvein very large, extending well into cell M_2 ; poststigmatic pale spot in cell R_5 3-lobed, L-shaped, nearly isolating a small round dark spot behind second radial cell; distal pale spot in cell R_5 irregularly shaped, broadly meeting wing margin anterodistad and narrowly touching pale line along vein M_1 posteriorly; vein M_1 pale margined distal to level of distal pale spot in cell R_5 , veins M_2 and M_{3+4} with only a pale spot at wing margin; cell M_1 with two elongate pale spots, the distal one nearly meeting wing margin; two pale spots in distal portion of cell M_2 , the apical one broadly meeting wing margin; cell M_4 with a small, round, pale spot in center of cell; anal cell with two separate pale spots in distal portion and base broadly pale with basal pale area covering a band across entire wing; cell M_2 with a pale spot lying in front of mediocubital fork and one lying behind medial fork. Macrotrichia sparse on distal third of wing in cells R_5 , M_1 and M_2 ; costa extending to 0.63 (0.62–0.68, $n=3$) of distance to wing tip. Halter yellowish, base of knob dark.

Abdomen.—Brownish black, cerci yellowish. Spermathecae two, ovoid, slightly unequal, measuring 0.050 by 0.034 mm. and 0.046 by 0.034 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with a broad, deep, caudomedian excavation; ninth tergum broad at apex, with long, slender, apico-lateral processes. Basistyle with ventral root foot-shaped, the posterior heel not developed, the dorsal root well developed; dististyle long, slender and gently curved, with pointed tip. Aedeagus with broad, pointed basal arch extending to more than three-fourths of total length, the basal arms stout and curved; distal portion a short lobe with rounded, simple tip. Parameres each with small basal knob, stem slender, gently curved and somewhat swollen in midportion, gradually tapered distad to long, simple filiform tip.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63167), allotype male, Almirante, Bocas del Toro Province, December 1952, F. S.

Blanton, light trap. Paratypes, 1 male, 7 females, same data except dates November and December 1952.

DISCUSSION: This species is very closely related to *mojingaensis* Wirth and Blanton, but can readily be distinguished by the submedian mesonotal spots being bluish instead of bright yellowish, vein M_2 not extensively pale margined distally, the distal pale spot in cell M_1 nearly meeting the wing margin, the apex of the male aedeagus stouter, and the tips of the parameres much slenderer.

48. *Culicoides mojingaensis* Wirth and Blanton

FIGURE 51

Culicoides mojingaensis Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 232 (male [sic], female; wing, mesonotum, palpus, spermathecae, male genitalia [sic]).

FEMALE: Length of wing 0.96 (0.89–1.02, $n=5$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 16:10:11:12:13:14:14:15:22:23:25:27:43, antennal ratio 1.32 (1.31–1.33, $n=2$), distal sensory tufts present on segments III, VIII–X, rarely present on VII. Palpal segments in proportion of 9:16:24:9:9, third segment moderately swollen, 2.1 (1.8–2.3, $n=5$) times as long as broad, with a broad, shallow, sensory pit. Mandible with 14 ($n=4$) teeth.

Thorax.—Mesonotum with a conspicuous 4-colored pattern; a median anterior marginal spot blackish; a pair of elongate submedian anterior spots yellowish; irregular lateral spots and prescutellar area bluish gray pollinose; and a pair of angular, sublateral bands, broadest at the lateral suture, deep brown. Scutellum brownish in middle, yellowish on the sides; postscutellum and pleuron dark brown. Legs dark brown, all femora with subapical, tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=7$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell very dark; r-m cross-vein in a very large pale spot extending from costal margin to half of distance across cell M_2 ; cell R_5 with two pale spots, a narrow, U-shaped, poststigmatic area which isolates a small, round, dark spot behind end of second radial cell, the distal pale spot in cell R_5 large and diamond-shaped, broadly meeting wing margin anterodistad and the posterior corner joined with pale line bordering vein M_1 ; two pale spots in cell M_1 , each fusing with the pale line bordering vein M_1 which extends distad from the proximal pale spot in cell M_1 , distal pale spot in cell M_1 located more than its own length from wing margin; distal third of vein M_2 pale-margined; cell M_2 with two pale spots in distal part, the distal one small and round and not quite meeting wing margin; apex of vein M_{3+4} with a pale spot at wing margin; cell M_4 with a large round pale spot in middle of cell, barely

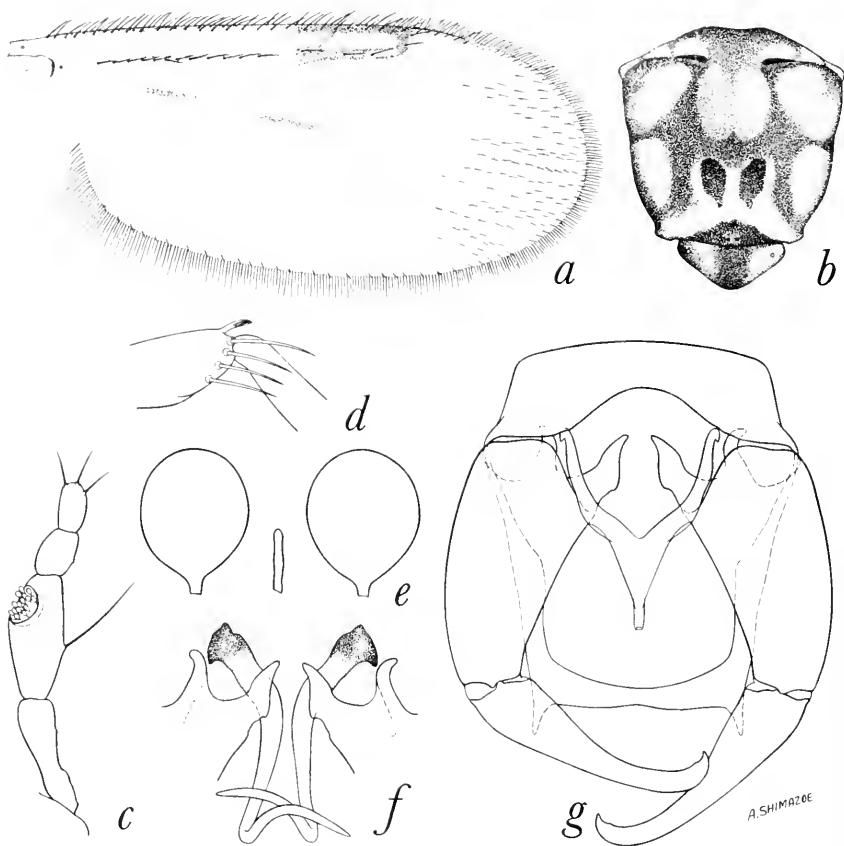


FIGURE 51.—*Culicoides mojingaensis* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

meeting wing margin; two small round pale spots in distal part of anal cell; cell M_2 with a small pale spot present in front of medio-cubital fork and one present behind medial fork; base of wing with large pale area extending into base of anal cell. Macrotrichia sparse on distal third of wing, none in cell M_4 or anal cell, costa extending to 0.66 (0.63–0.68, $n=5$) of distance to wing tip. Halter pale, base of the knob dark.

Abdomen.—Brownish black, cerci yellowish. Spermathecae two, oval, slightly unequal, measuring 0.049 by 0.038 and 0.039 by 0.034 mm., the bases of the ducts sclerotized a very short distance.

MALE GENITALIA.—Ninth sternum with a relatively narrow, deep, caudomedian excavation; ninth tergum broad at the apex with slender, pointed, apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel not developed, dorsal root slender; disti-

style slender, with bent, pointed apex. Aedeagus with pointed basal arch extending to half of total length, the basal arms slender and curved, distal portion tapered to very slender distal point. Parameres each with large basal knob, stem gently curving and moderately stout on basal portion, midportion slender and straight, ventral lobe absent, abruptly curved to relatively stout, long simple tip.

DISTRIBUTION: Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Fort San Lorenzo, Fort Sherman, Loma Boracho, Mojinga Swamp (type locality).

LOS SANTOS PROVINCE: Pan de Azucar.

PANAMÁ PROVINCE: Arraiján.

DISCUSSION: Our original description of the male genitalia of *mojingaensis* was based on a misidentified specimen of *paucienfuscatus*. We have seen correctly associated males from most of the above localities, and on these the present description of the male is based.

This species is related to *paucienfuscatus* Barbosa, *bricenoi* Ortiz, and *azureus*, new species, all of which have the distal pale spot in cell M_1 nearly attaining wing margin. *Paucienfuscatus* and *bricenoi* have the pale wing spots much more extensive with the pale margins of veins M_1 and M_2 connected extensively to the discal pale wing spots. In *azureus* vein M_2 is pale only on a small apical spot at the wing margin and the parameres are slenderer, while in *bricenoi* the parameres have remarkable spatulate tips. *Bricenoi* is known only from Venezuela and Ecuador.

49. *Culicoides paucienfuscatus* Barbosa

FIGURE 52

Culicoides paucienfuscatus Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 23 (female; Brazil, Panama; fig. wing, palpus).

Culicoides mojingaensis Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 232 (in part, male allotype was misdetermined).

FEMALE: Length of wing 1.02 (0.84–1.16, $n=13$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:14:14:14:13:14:13:13:21:21:23:23:36, antennal ratio 1.18 (1.02–1.34, $n=8$); distal sensory tufts present on segments III, VII–X, rarely absent on VII. Palpal segments in proportion of 11:26:28:9:12, third segment moderately swollen, 2.21 (1.80–2.73, $n=13$) times as long as greatest breadth, with a moderately large, deep, sensory pit. Mandible with 12 (11–15, $n=12$) teeth.

Thorax.—Mesonotum pruinose blackish brown on anterior and lateral margins, midportion grayish brown pruinose, with pattern of elongate, longitudinal oval patches delimited by three narrow dark

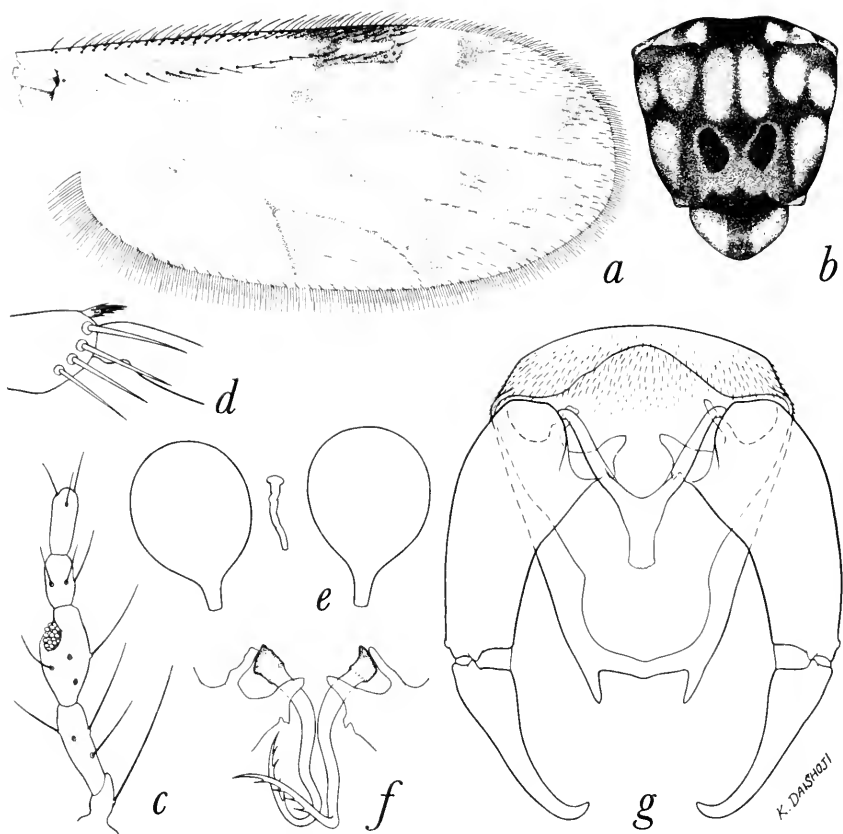


FIGURE 52.—*Culicoides paucienfuscatus* Barbosa. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

brown longitudinal lines with a transverse line at level of lateral suture. Scutellum narrowly blackish in middle, yellowish on sides; post-scutellum and pleuron blackish. Legs dark brown; all femora with subapical, tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four 4 ($n=12$) spines, the two nearest the spur longest, subequal.

Wing.—Pattern as figured; second radial cell very dark; very large pale spot over r-m crossvein, broadly reaching costal margin and extending through half the breadth of cell M_2 ; wing pattern appearing as limited dark spots on a pale ground due to extensive fusion of the pale spots; pale spots at post-stigmatic level continued as an unbroken band to hind wing margin, distad of this band veins M_1 , M_2 and M_{3+4} are pale margined; cell R_5 with a C-shaped pale poststigmatic pale spot

isolating a small round black spot behind apex of second radial cell; distal pale spot in cell R_5 quadrate, broadly extending across cell from anterior wing margin to vein M_1 ; two pale spots present in cell M_1 , the proximal one merged into transverse band of wing, the distal one failing by less than its length to meet wing margin; two pale spots in distal part of cell M_2 , the distal one meeting wing margin; pale spot in cell M_4 large and broadly meeting wing margin; two pale spots in distal portion of anal cell; cell M_2 with small pale spot in front of mediocubital fork and a pale spot behind medial fork; base of wing broadly pale. Macrotrichia numerous on distal half of wing, a few in cell M_4 and anal cell; costa extending to 0.63 (0.60–0.66, $n=12$) of distance to wing tip. Halter yellowish.

Abdomen.—Dark brown; cerci pale. Spermathecae two, pyriform, slightly unequal, measuring 0.055 by 0.038 mm. and 0.050 by 0.036 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with a moderately deep caudo-median excavation, the ventral membrane spiculate; ninth tergum long and tapering, the apicolateral processes long and pointed. Basistyle with ventral root foot-shaped, dorsal root slender; dististyle long and slender, moderately curved. Aedeagus with rounded basal arch extending to about half of total length, the basal arms curved and slender, the distal apex slender and rounded with fine distal spinules. Parameres each with large basal knob, stem gently curved on basal portion, slender, distally slightly sinuate, without ventral lobe, very long, with pointed tip bearing a lateral fringe of fine spines.

DISTRIBUTION: Brazil; Panama; Trinidad (Tucker Valley).

PANAMA RECORDS.

CANAL ZONE: Camp Piña, Fort Davis, Fort San Lorenzo, Fort Sherman, Loma Boracho, Madden Dam, Mojinga Swamp.

COLÓN PROVINCE: Nuevo Chagres, Piña.

DARIÉN PROVINCE: El Real, Jaqué, Punta Patiño.

PANAMÁ PROVINCE: La Jolla, Pacora, Pedregal, Río Trinidad (Busck, coll.), Tocumen.

VERAGUAS PROVINCE: Río Santa María.

DISCUSSION: Barbosa described *paucienfuscatus* from two cotype specimens in the U. S. National Museum: a pinned female from Manaus, Amazonas, Brazil, June 1931, R. C. Shannon, which we are here designating the lectotype, and a female (paratype), mounted on a slide, from Río Trinidad, Panama, June 9, 1912, A. Busck.

This species, while remaining remarkably constant in color and wing pattern characters and male genitalic structure, exhibits an interesting type of variation in structural characters which we suspect may lead to the recognition of subspecies when more distributional records are obtained. For example, the Panama specimens from near the Canal Zone have a much stouter third palpal segment (1.64–2.09 times as

long as broad) and an antennal ratio of 1.07–1.12. A series of specimens measured from Trinidad, B. W. I., have the palpal ratio 2.15 to 2.64 and the antennal ratio 1.28–1.34. Furthermore, specimens from Jaqué in Darién Province and Río Santa María in Veraguas have an even slenderer palpus (2.4–2.73) and shorter distal antennal segments (antennal ratio, 1.02–1.19).

The extreme development and confluence of the pale areas of the wing and the unicolorous grayish brown mesonotum with a pattern of narrow dark brown lines will readily separate *paucienfuscatus* from the related species, *mojingaensis* and *azureus*.

50. *Culicoides pifanoi* Ortiz

FIGURE 53

Culicoides pifanoi Ortiz, 1951, Rev. Sanid. Asist. Soc., vol. 16, p. 588 (male, female; San Felipe, Yaracuy, Venezuela; fig. wing, mesonotum, palpus, antenna, spermathecae, male genitalia); 1954, Arch. Venezolana Patol. Trop. Parasit. Med., vol. 2, p. 225 (female; fig. wing, palpus, spermathecae, antenna).—Fox, 1955, Journ. Agr. Univ. Puerto Rico, vol. 39, p. 251 (synonym, *tricoloratus* Wirth and Blanton).

Culicoides tricoloratus Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 233 (male, female; Panama, Florida; fig. wing, mesonotum, palpus, male genitalia).

FEMALE: Length of wing 0.79 (0.73–0.89, $n=9$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 14:10:11:13:12:12:13:13:14:16:16:16:26, antennal ratio 0.91 (0.84–0.97, $n=6$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 7:16:16:7:7, third segment moderately swollen, 1.8 (1.6–1.9, $n=8$) times as long as greatest breadth, with a large, shallow sensory pit. Mandible with 14 (12–15, $n=6$) teeth.

Thorax.—Mesonotum dark brown with a pair of elongate, submedian, yellowish spots on disc and two sublateral pairs of irregularly rounded, bluish pruinose light spots. Scutellum narrowly dark brown in middle, sides paler. Postscutellum dark brown, pleuron light brown, darker across middle transversely. Legs dark brown; fore and mid femora with subapical (a faint trace of subapical pale ring on hind femur of some specimens), all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=9$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, pale spot over r-m crossvein extensive; poststigmatic pale spot consisting of a single spot extending from anterior wing margin around end and posterior side of second radial cell and narrowly connected proximad to the pale spot over r-m crossvein; distal pale spot in cell R_5 more or less quadrate in outline with one side meeting wing margin and one corner nearly meeting the pale

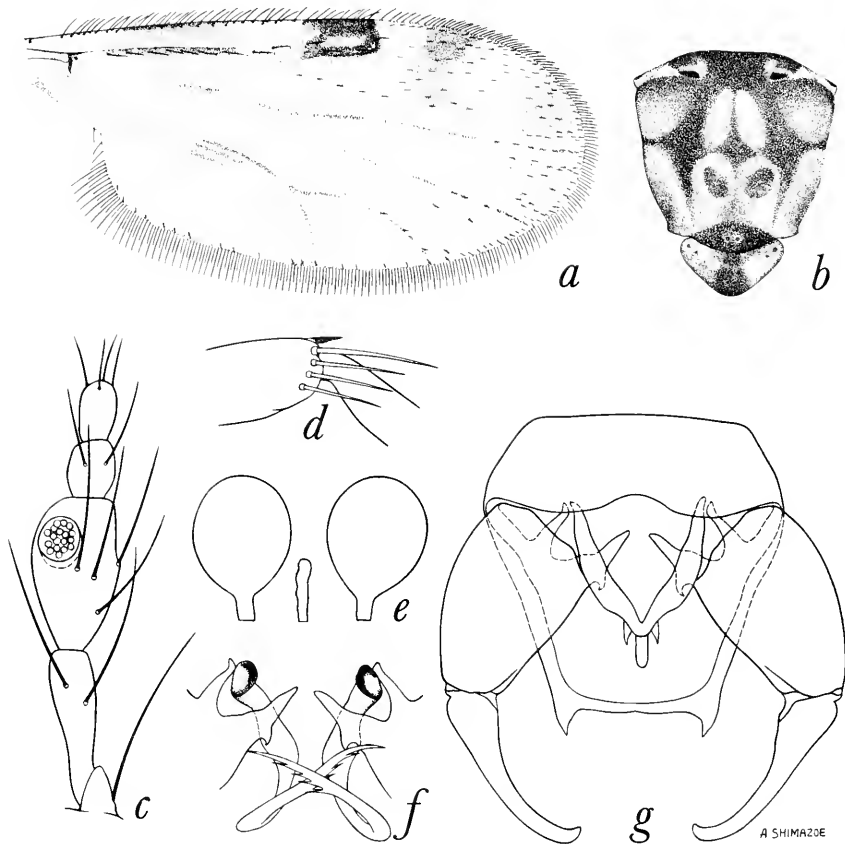


FIGURE 53.—*Culicoides pifanoi* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

line along vein M_1 ; veins M_1 and M_2 pale margined on their distal halves, the basal pale spot in cell M_1 joined to these pale lines, the distal pale spot in cell M_1 far removed from wing margin; the two distal pale spots in cell M_2 not connected; cell M_4 with large pale spot; two pale spots in distal part of anal cell; pale spots lying ahead of medio-cubital fork and behind medial fork joined by a pale area extending to base of wing; proximal fifth of wing pale from costal margin to anal angle of anal cell. Macrotrichia scanty, only a few in cells R_5 and M_1 ; costa extending to 0.60 (0.58–0.62, $n=9$) of distance to wing tip. Halter pale.

Abdomen.—Brown, terga more or less pale; cerci pale. Spermathecae two, ovoid, unequal, measuring 0.049 by 0.046 mm. and 0.038 by 0.026 mm., the bases of the ducts sclerotized for a distance of about a fourth the length of spermathecae.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum short and tapering with small apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel small, the toe slender, dorsal root slender; dististyle slender and curved with slightly expanded apex. Aedeagus with basal arch extending to about three-fourths of total length, narrow at the mesal apex, the stout basal arms nearly straight; distal stem slender and flanked by a subapical pair of sclerotized points. Parameres each with large basal knob, stem slender at base, abruptly bent at about midlength of stem, this portion slightly swollen, the distal portion of stem tapering gradually, without ventral lobe, abruptly bent and tapered to fine apical point, with a subapical fringe of well-developed barbs.

DISTRIBUTION: Venezuela; Florida; Honduras (Lancetilla); Nicaragua (Villa Somoza); Panama; Trinidad.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Barro Colorado Island, Fort Davis, Fort Sherman, Gamboa, Madden Dam, Mojinga Swamp.

COLÓN PROVINCE: Piña.

DARIÉN PROVINCE: El Real, Garachiné, Punta Patiño.

PANAMÁ PROVINCE: Arraiján, Cerro Campana, Pacora (type locality of *tricoloratus*).

DISCUSSION.—Among those species with dark second radial cell and prominent mesonotal pattern and large distal pale spot in cell R_5 broadly meeting wing margin, this species is readily identified by the extensive pale margins to veins M_1 and M_2 which are connected to the pale spots in cell M_1 and in apex of cell R_5 , with the distal spot in cell M_1 much smaller than its distance from the wing margin. In some specimens the bluish pruinosity of the lateral pale areas of the mesonotum is not evident and in some there is an indication of a subapical pale band on the hind femur.

51. *Culicoides dicrourus* Wirth and Blanton

FIGURE 54

Culicoides dicrourus Wirth and Blanton, 1955, Bull. Brooklyn Ent. Soc., vol. 50, p. 123 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.14 (1.02–1.25, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 19:16:16:16:17:17:17:23:25:27:41, antennal ratio 1.04 (0.98–1.07, $n=4$); distal sensory tufts present on segments III, VI–X. Palpal segments in proportion of 10:22:28:10:10, third segment swollen, 2.1 (1.9–2.3, $n=8$) times as long as greatest

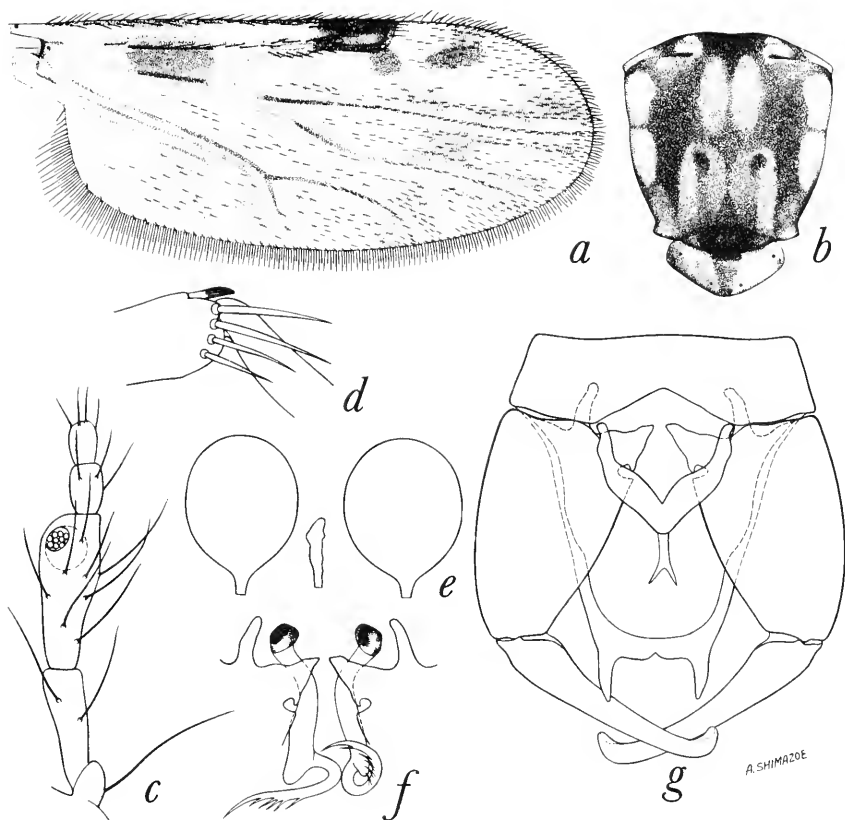


FIGURE 54.—*Culicoides dicrourus* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

breadth, with a large sensory pit opening by a slightly smaller pore. Mandible with 13 (12-14, $n=11$) teeth.

Thorax.—Mesonotum elongated, dark brown, with a prominent pattern of yellowish patches as figured. Scutellum narrowly dark in middle, yellowish on sides. Legs dark brown, all femora with subapical, tibiae with subbasal and hind tibia with apical, broad yellowish bands: four distal tarsomeres pale; hind tibial comb with four ($n=9$) spines, the two adjacent to the spur longest, subequal.

Wings.—Pattern as figured, large yellow spots at base of wing and over r-m crossvein; cell R_5 with two large pale marks, the poststigmatic spot roughly in the form of an incomplete circle isolating a small black round spot just behind end of second radial cell, distal pale spot in cell R_5 oblique and hourglass-shaped, very broadly meeting the

anterior wing margin; cell M_1 with two elongate pale spots, the distal one attaining distal wing margin; large pale spots present in ends of cells M_2 and M_4 , pale areas in cell M_2 at base, one lying behind medial fork, one lying in front of mediocubital fork and another between the latter two and the pale spot at apex of cell M_2 , all the proximal spots in cell M_2 narrowly connected by a pale line running through the axis of cell; two pale spots in distal portion of anal cell more or less coalesced. Macrotrichia sparse over distal half of wing and in anal cell; costa extending to 0.65 (0.63–0.67, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown. Spermathecae two, pyriform, slightly unequal, measuring 0.070 by 0.050 mm. and 0.062 by 0.042 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum long and tapered, apicolateral processes long and closely approximated. Basistyle with ventral root broad and foot-shaped, with distinct heel and flat sole, dorsal root short and slender; dististyle long and slender, apex slightly curved. Aedeagus with short, broad, pointed basal arch, the basal arms rather stout, median portion long and slender with a deeply bifid (2-pronged) apex. Parameres each with knobbed base, stem stout and nearly straight with a subapical ventral lobe, distal portion greatly narrowed to a curved, flattened, distally pointed blade with about five lateral barbs.

DISTRIBUTION: Panama; Honduras; Mexico; Nicaragua.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Atlantic side; Fort Clayton, Fort Davis, Fort Gulick; Fort Sherman, France Field, Huile Sia Clara(?), Loma Boracho (type locality), Madden Dam, Mindi Dairy, Mojinga Swamp, Tabernilla.

CHIRIQUÍ PROVINCE: Concepción, David, Tortugas.

COLÓN PROVINCE: Cativá, Piña.

DARIÉN PROVINCE: El Real, Garachiné, Jaqué.

PANAMÁ PROVINCE: Arraiján, Capitana, La Jolla, Pedregal, Isla Taboga, Tocumen.

VERAGUAS PROVINCE: Río Santa María, Las Palmas.

DISCUSSION: Two species from Venezuela, *discrepans* Ortiz and Mirsa and *avilaensis* Ortiz and Mirsa, are closely related to *dicrourus*. The former species is larger (wing 1.9 mm. long), wing with the pale spot at the end of the costa entire, not broken into two more or less separate spots and the lower portion not bending around U-shaped proximad toward vein R_{4+5} and not isolating a separate black spot behind end of second radial cell, the three discal pale spots in cell M are discrete and not connected by a long pale line, there are

antennal sensoria only on segments III, VIII-X, palpal segments IV and V combined are only 0.88 as long as III and the sensory pit on the third palpal segment is deeper with a narrower opening. *C. avilaensis* has the pale wing spots even more reduced than in *discrepans*.

52. *Culicoides volcanensis*, new species

FIGURE 55

FEMALE: Length of wing 1.45 mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 30:24:24:25:25:26:24:24:33:35:41:43:65, antennal ratio 1.07; distal sensory tufts present on segments III, VII-X. Palpal segments in proportion of 9:15:30:7:10, third segment moderately swollen, 2.1 times as long as greatest breadth, with a broad, shallow sensory pit. Mandible with 13 teeth.

Thorax.—Mesonotum slender and long, very convex on front portion; color a deep chocolate brown, anterior margin blackish, with a submedian anterior pair of elongate spots, a prescutellar area, two small spots in area of humeral pit and three small lateral spots on each side yellowish. Scutellum broadly dark brown in middle, yellowish on sides; postscutellum dark brown, pleuron yellowish above, dark

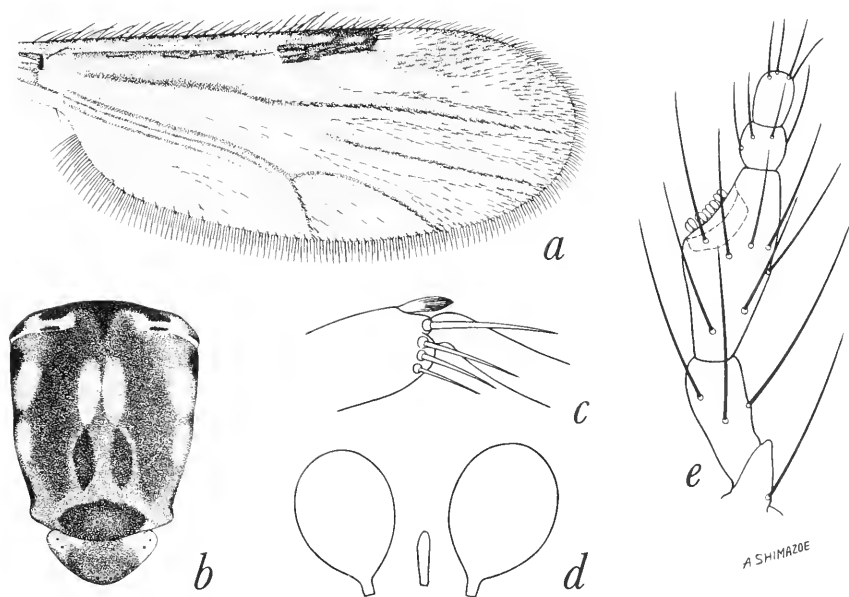


FIGURE 55.—*Culicoides volcanensis*, new species. Female: a, wing; b, thoracic pattern; c, tibial comb; d, spermathecae; e, palpus.

brown below. Legs dark brown, femora with subapical, tibiae with subbasal and hind tibia with apical, narrow pale rings; knee spots blackish; hind tibial comb with four spines, the one nearest the spur longest.

Wing.—Very long and narrow, four times as long as broad; with pattern as figured; pale areas of wing few and not prominent; second radial cell very dark; pale area over r-m crossvein continued in full breadth to costal margin; two well-separated, round, pale, poststigmatic spots in cell R_5 , the posterior one located slightly proximad of the other; distal pale spot in cell R_5 small and oblique, meeting wing margin in slightly reduced breadth; apex of vein M_1 with a pale spot at wing margin; cell M_1 with two small pale spots, the distal one elongate and not quite meeting wing margin; two pale spots in distal portion of cell M_2 , the proximal one very small and faint, the distal one lying at wing margin; large pale spot in cell M_4 ; a single, large double pale spot in distal portion of anal cell; a pale spot in cell M_2 lying in front of mediocubital fork and one lying behind medial fork; a pale spot over basal arculus. Macrotrichia sparse over distal half of wing and a few in middle of anal cell; costa extending to 0.61 of distance to wing tip. Halter yellowish, base of the knob infuscated.

Abdomen.—Dark brown. Spermathecae two, collapsed in single slide specimen and not measured, apparently subequal and pyriform, with the bases of the ducts sclerotized a short distance.

MALE: Unknown.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63168); 1 female paratype, Volcán, Chiriquí Province, Panama, May 28, 1954, G. Field, light trap.

DISCUSSION: This is such a distinctive species that we do not hesitate to describe it as new from two specimens, one pinned (holotype) and the other mounted on a slide. The large size, elongated, convex mesonotum, striking yellowish and brown markings of the thorax and legs, the sensorial pattern, palpal structure and number of mandibular teeth seem to ally this species with *dicrourus* Wirth and Blanton, *avilaensis* Ortiz and Mirsa, and *discrepans* Ortiz and Mirsa. These three species, however, all have more extensive pale wing markings, a large area at wing base pale, the penultimate spot in cell M_2 well developed, the pale spot in the distal part of the anal cell more nearly or distinctly separated into two separate pale spots and the wing much hairier. *C. discrepans* is a much larger species (wing 1.9 mm. long) and *avilaensis* and *dicrourus* are smaller (wing 1.1–1.3 mm. long) than *volcanensis*.

53. *Culicoides lyrinotatus* Wirth and Blanton

FIGURE 56

Culicoides lyrinotatus Wirth and Blanton, 1955, Bull. Brooklyn Ent. Soc., vol. 50, p. 126 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.17 (1.12–1.22, $n=2$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 28:24:24:26:24:25:25:25:26:27:35:37:58, antennal ratio 1.01; distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 8:20:20:10:10, third segment swollen, 2.27 times as long as greatest breadth, with a very broad, shallow, sensory pit. Mandible with 12 teeth.

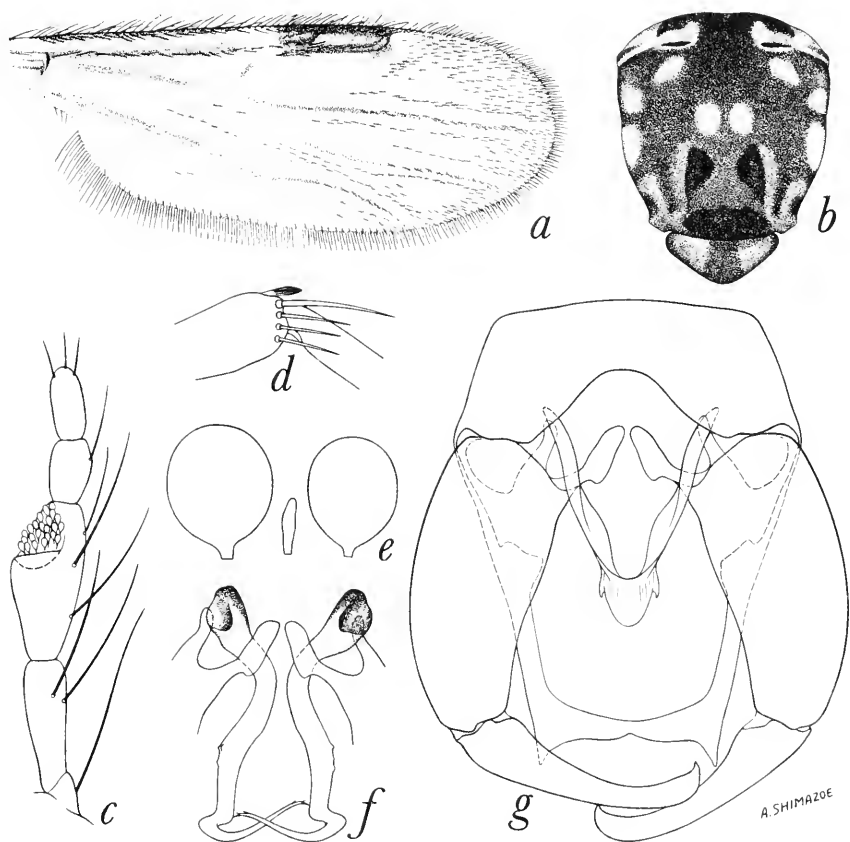


FIGURE 56.—*Culicoides lyrinotatus* Wirth and Blanton. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum dark brown, with prominent pattern of small, yellowish-white spots arranged as follows: a pair on humeri; two pairs of elongate submedian spots, one at suture, the other in the prescutellar depression; five pairs of very small spots in a pair of lyre-shaped, curving lines, the anteriormost pair covering sensory pits, the second pair behind and slightly laterad, third and fourth pairs on lateral margins on each side of suture and the fifth pair above the wing bases. Scutellum broadly black in the middle, yellowish on sides, extreme sides narrowly black. Postscutellum and pleuron dark brown. Legs dark brown, femora with subapical, tibiae with subbasal, and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=2$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, the distal wing spots forming a wheel-like pattern; second radial cell long, very dark; r-m crossvein dark, with a very small pale spot from anterior end to costal margin and a smaller pale spot at the posterior juncture with the media; cell R_5 with three small round spots in a triangle at end of costa and a small spot near base of cell forming a triangle with the two pale spots at ends of r-m crossvein; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 each with a small pale spot at wing margin; cell M_1 with two oval pale spots, the distal one far from wing margin; one pale spot in distal part of cell M_2 ; a small pale spot in center of cell M_4 ; anal cell with two small pale spots in distal portion and a small pale spot near hind margin at base; cell M_2 with small pale spot lying in front of mediocubital fork and one lying behind medial fork. Macrotrichia numerous on distal half of wing and on distal part of anal cell; costa extending to 0.68 (0.67–0.71, $n=3$) of distance to wing tip. Halter knob infuscated.

Abdomen.—Brownish black, cerci yellowish. Spermathecae two, pyriform, large, subequal, collapsed in available specimens and not measured, bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with a deep caudomedian excavation; ninth tergum tapering, with short, pointed apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel poorly developed, dorsal root slender; dististyle slender with bent, pointed tip. Aedeagus with rather narrow, pointed, basal arch extending to 0.8 of total length, the basal arms stout and nearly straight; distal portion a short, rounded, faintly sclerotized blade with a pair of lateral, subapical points. Parameres each with stout basal knob, stem slender, strongly bent at base, sinuate in midportion, abruptly bent at base of tapered distal portion which is narrowed to a fine point with a few very minute, subapical spines.

DISTRIBUTION: Panama; Nicaragua (Villa Somoza).

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante (type locality).

DISCUSSION: This species and *reticulatus* Lutz belong in the group with *paucienfuscatus* Barbosa on structural features in spite of the reduction of the wing markings to numerous small round pale spots. The distinctive arrangement of these spots in a wheel-like pattern on the distal part of the wing and the dark crossvein with small pale spots on each end will readily serve to identify *lyrinotatus*.

54. *Culicoides reticulatus* Lutz

FIGURE 57

Culicoides reticulatus Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 49 (male, female; Santos, Rio de Janeiro, and Bahia, Brazil; biology, larvae in crab holes in mangrove edge; fig. wing, palpus, male).—Barbosa, 1943, Rev. Brasil. Biol., vol. 3, p. 261 (Brazil; fig. wings, palpus, male genitalia).—Forattini and Galvao, 1955, Rev. Brasileira Malariologia, vol. 7, p. 229 (male, female; Brazil, Panama; fig. wing, mesonotum, palpus, antenna, male genitalia).

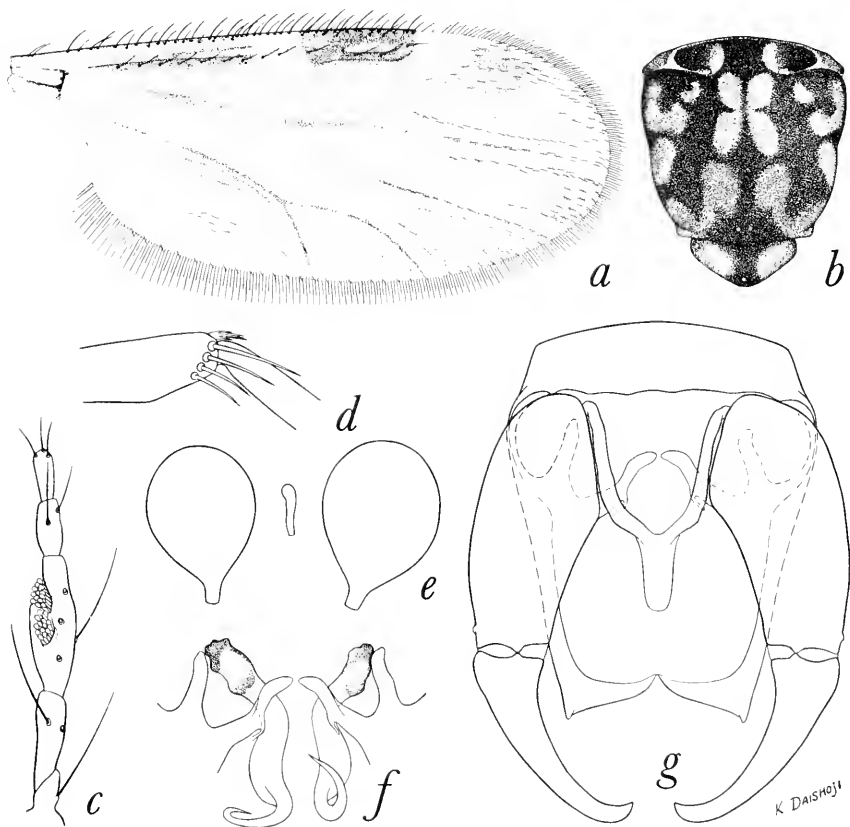


FIGURE 57.—*Culicoides reticulatus* Lutz. a-e, Female: a, wing; b, thoracic pattern; c, palpus; d, tibial comb; e, spermathecae. f, g, Male: f, parameres; g, genitalia, parameres removed.

FEMALE: Length of wing 0.96 (0.89–1.06, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 19:14:15:16:16:16:16:22:24:26:44, antennal ratio 1.10 (1.08–1.11, $n=3$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 10:22:34:13:15, third segment extremely long, slightly swollen, 2.8 (2.4–3.3, $n=1$) times as long as greatest breadth, with a very large, shallow, irregular, generally double sensory pit. Mandible with 21 (20–22, $n=7$) teeth.

Thorax.—Mesonotum dark brown with a very prominent pattern of yellowish patches, median anterior area with four spots arranged in a four-leaf-clover design, lateral areas with 4–5 small pale spots, prescutellar depression pale. Scutellum narrowly brown in middle, yellowish on sides; postscutellum and pleuron dark brown. Legs dark brown, bases of femora pale; femora with subapical, tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=9$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell long and fairly broad; pale spot over r-m crossvein broken into two spots by a dark area at anterior end of crossvein, the posterior one small and round, the anterior one slightly larger; cell R_5 with four small, well-separated, pale spots arranged in a rhomboid, the distal one broadly extended to wing margin; apices of veins M_1 , M_2 and M_{3+4} each with a pale spot at wing margin; two pale spots in cell M_1 , the second located far from wing margin; two pale spots in distal part of cell M_2 ; cell M_4 with a small round pale spot in center of cell; two separate pale spots in distal part of anal cell and an irregular pale area at base; cell M_2 with a distinct pale spot lying behind medial fork and one lying in front of mediocubital fork, one lying near base of cell; pale spot present at basal arculus. Macrotrichia sparse on distal third of wing; costa extending to 0.65 (0.64–0.67, $n=10$) of distance to wing tip. Halter knob brownish at base.

Abdomen.—Dark brown, cerci pale. Spermathecae two, pyriform, slightly unequal, measuring 0.056 by 0.042 and 0.049 by 0.036 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum without apparent caudomedian excavation; ninth tergum with well-developed median cleft on caudal margin, the apicolateral processes very short and blunt. Basistyle with ventral root foot-shaped, the posterior heel very poorly developed, dorsal root slender; dististyle nearly straight, slender, with bent tip. Aedeagus with pointed basal arch extending to two-thirds of total length, the basal arms slightly curved and slender; posterior portion slender with simple, rounded tip. Parameres each with large basal knob, stem moderately stout, bent near base, midportion slightly

swollen with very low ventral lobe, distal portion tapered to relatively stout, pointed, simple apex.

DISTRIBUTION: Brazil; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort San Lorenzo, Fort Sherman, France Field, Galeta Point, Loma Boracho, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Alanje.

COCLÉ PROVINCE: Puerto Farallón, Puerto Obaldía.

COLÓN PROVINCE: Cativá, Piña.

DARIÉN PROVINCE: El Real, Garachiné, Punta Patiño.

LOS SANTOS PROVINCE: Guararé, La Palma, Las Tablas, Puerto Mensabé.

PANAMÁ PROVINCE: Arraiján, Camarón, Panamá Vieja, Pedregal, Venado Beach, Viqueé Cove.

DISCUSSION: This species is closely related to *lyrinotatus* Wirth and Blanton, both species having the distinctive division of the pale spot over the r-m crossvein into two separate pale spots. The two species agree also in many other less conspicuous details including the general wing pattern, but *lyrinotatus* can readily be distinguished by the wheel-like design of the pale wing spots and the dark crossvein, while the four-leaf-clover design of the anterior mesonotal spots will distinguish *reticulatus* from all other known species. The male parameres of *reticulatus* greatly resemble those of *mojingaensis* and *azureus*.

55. *Culicoides macrostigma* Wirth and Blanton

FIGURE 58

Culicoides macrostigma Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 230 (male, female; Panama; fig. wing, palpus, male genitalia).

FEMALE: Length of wing 0.91 (0.83–0.96, n=9) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 15:8:9:9:10:10:11:12:28:28:29:29:48, antennal ratio 1.97; distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 9:14:20:9:10, third segment swollen, 1.8 (1.6–2.0, n=8) times as long as greatest breadth, with a large deep sensory pit opening by a small pore. Mandible with 11 (9–12, n=9) teeth.

Thorax.—Mesonotum dark chocolate brown, with prominent pattern of pruinose gray patches consisting of a pair of elongate, submedian spots, a pair of small humeral spots, and two pairs of rounded lateral spots, one on each side of lateral suture. Scutellum brown in middle, pruinose gray on the sides; postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with

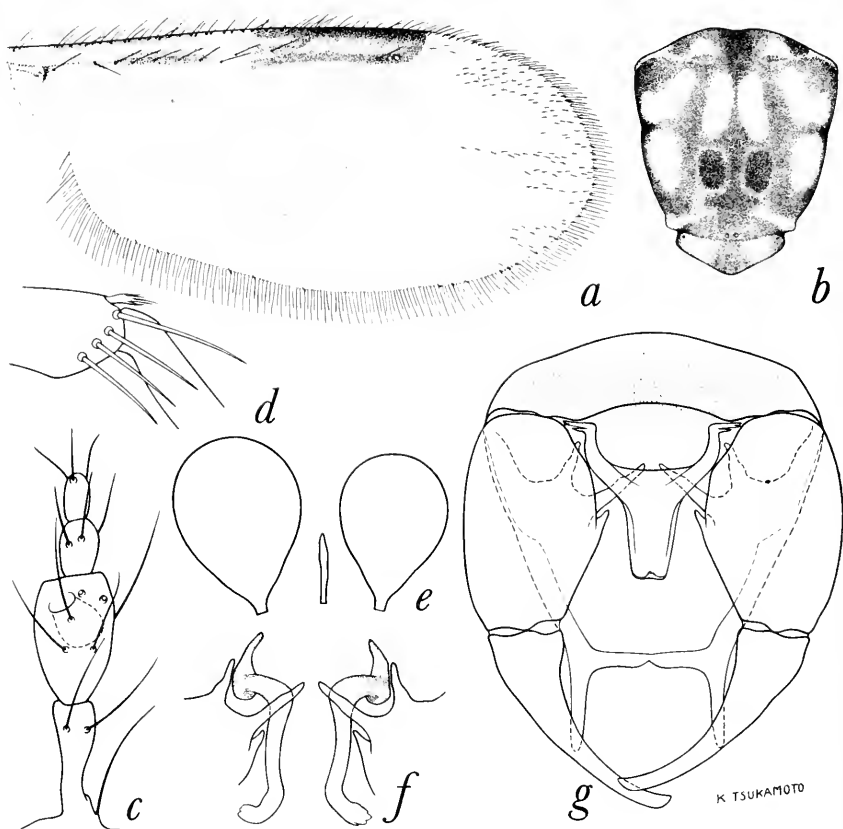


FIGURE 58.—*Culicoides macrostigma* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=8$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell dark, quite broad and very long, over twice as long as first; pale spot over r-m cross-vein continued broadly to costal margin; cell R_5 with four well-separated, small pale spots, two in a longitudinal row behind second radial cell, one at wing margin at end of costa and the distal one located in middle of cell toward the apex, the distal side of the last spot concaved; two pale spots in cell M_1 , the second located far from wing margin; two pale spots in distal part of cell M_2 , the apical one rounded and located at wing margin; one pale spot in cell M_4 , not touching the veins or wing margin; two pale spots in distal portion of anal cell; a pale spot in cell M_2 lying in front of mediocubital fork and another behind medial fork; a pale spot at basal arcus of wing;

a very narrow transverse pale mark across extreme apex of wing. Macrotrichia very scanty, only a few in apices of cells R_5 and M_1 ; costa extending to 0.71 (0.70–0.74, $n=9$) of distance to wing tip. Halter pale.

Abdomen.—Brownish black. Spermathecae two, pyriform, unequal, measuring 0.063 by 0.039 mm. and 0.052 by 0.038 mm., the bases of the ducts sclerotized a very short distance.

MALE GENITALIA: Ninth sternum with very broad, shallow, caudo-median excavation, the posterior membrane spiculate; ninth tergum short and tapered, with very long, slender, fingerlike, closely approximated, apicolateral processes. Basistyle with ventral root very slender, long and pointed, dorsal root stouter and about half as long; dististyle curved, tapered to slender point. Aedeagus with basal arch about 1.5 times as broad as high, basal arms very short and curved; distal portion very broad, about twice as long as broad, with truncated apex. Parameres each with very broadly expanded, laterally directed basal knob bearing a distinct anterior process, stem very short, swollen at base, stout on distal portion with extreme tip expanded and abruptly bent laterad in the shape of a beak.

DISTRIBUTION: Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Fort Sherman, Loma Boracho, Mojinga Swamp (type locality).

DARIÉN PROVINCE: Punta Patiño.

PANAMÁ PROVINCE: Tocumen.

DISCUSSION: The relations of *macrostigma* are uncertain, but this species is probably related to *mojingaensis* Wirth and Blanton and *bricenoi* Ortiz. Features which support its assignment to the group with these two species are the basic arrangement of the four pale spots in cell R_5 with two spots behind the second radial cell, the sensorial pattern with sensoria present on segments III, VIII–X, the shape of the male aedeagus, the long male apicolateral processes and the spiculate membrane on the ninth sternum. The male parameres are bluntly expanded apically as in *bricenoi*, but in a different shape. The shape of the basal knob of the paramere as well as the long slender simple ventral root of the male basistyle are quite different, however, and prevent *macrostigma* from being assigned to this group with any degree of confidence.

The *furens* group

This group consists of small to medium-sized species, frequently with pale spots at the extreme apices of cells R_5 and M_1 and a mesonotal pattern of small punctiform brown dots; female antenna with sensoria

present on segments III, VII or VIII to X; four tibial spines; two spermathecae; male genitalia with ventral root of basistyle foot-shaped; paramere with basal knob simple, ventral lobe usually present and well developed and apex with fringing spines; aedeagus usually V-shaped with pointed basal arch and distal portion with subapical points.

PANAMA SPECIES: Four: *alahialinus* Barbosa, *barbosai* Wirth and Blanton, *furens* (Poey), and *gorgasi* Wirth and Blanton.

56. *Culicoides alahialinus* Barbosa

FIGURE 59

Culicoides alahialinus Barbosa, 1952, Nov. Subs. Conhec. Culicoides Neotr., p. 11 (female; Limones, Esmeraldas, Ecuador; fig. wing, palpus).—Ortiz and Leon, 1955, Bol. Inf. Cient. Nac., vol. 67, p. 571 (Ecuador, female redescribed; fig. wing, palpus, antenna, spermathecae).

FEMALE: Length of wing 0.96 (0.89–1.02, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 20:14:14:14:14:14:14:14:20:20:22:22:34, antennal ratio 1.01 (0.94–1.11, $n=9$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 9:21:24:10:12, third segment moderately swollen, 2.2 (2.0–2.4, $n=8$) times as long as greatest breadth, with moderately large, shallow, sensory pit. Mandible with 15 (15–16, $n=7$) teeth.

Thorax.—Mesonotum slightly shining brown, with faint grayish pollen, punctiform brown dots scattered at insertions of mesonotal hairs, no discal pale area apparent. Scutellum dark brown in middle, paler on sides; postscutellum and pleuron dark brown. Legs pale brown, knees blackish; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, very faint, narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—With very faint pattern as figured, appearing grayish; yellowish pale area at wing base and over r-m crossvein; very faint indications of pale spots in cells on distal part of wing located as in *gorgasi*. Macrotrichia sparse but well distributed on distal half of wing and in anal cell; costa extending to 0.64 (0.61–0.68, $n=10$) of distance to wing tip. Halter infuscated.

Abdomen.—Blackish, cerci pale. Spermathecae two, slightly pyriform, slightly unequal, measuring 0.055 by 0.036 mm. and 0.048 by 0.036 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with a deep caudomedian excavation; ninth tergum long, broad at apex with slender apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root slender; dististyle long and curving to pointed tip. Aedeagus with

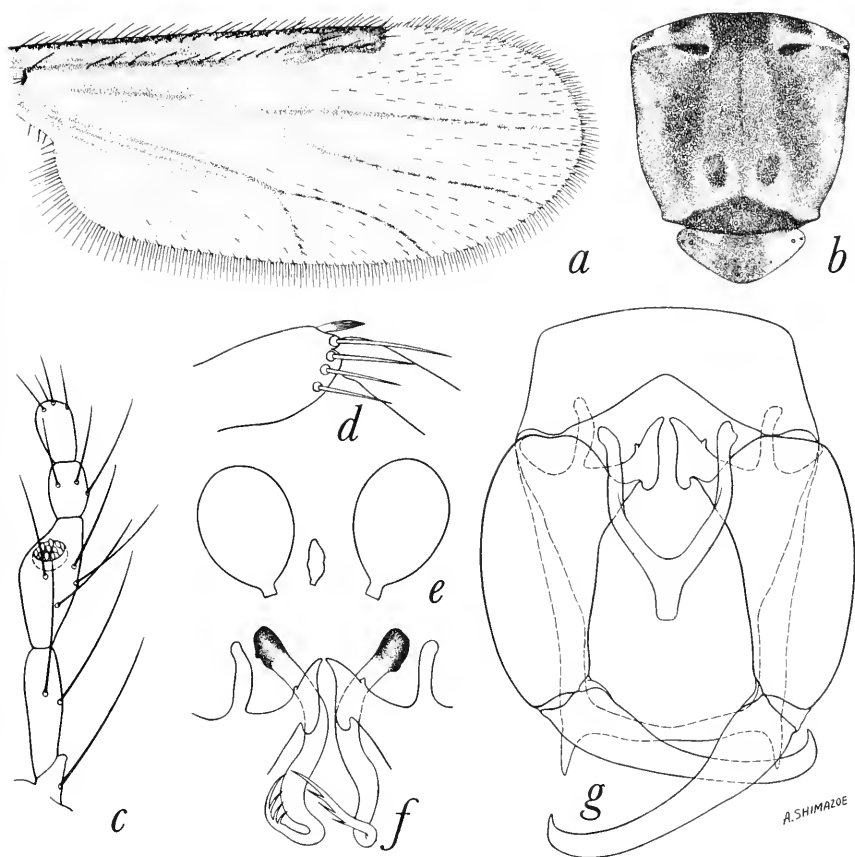


FIGURE 59.—*Culicoides alahialinus* Barbosa. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

basal arch extending to about two-thirds of total length of aedeagus, basal arms curved, distal portion with rounded apex and indistinct subapical lateral points. Parameres each with basal knob, stem bent near base, slightly sinuate in midportion, without ventral lobe, distal portion abruptly bent and twisted ventrad, the sharp tip with several fine subapical hairs.

DISTRIBUTION: Ecuador; Panama.

PANAMA RECORDS:

CANAL ZONE: Balboa, Fort Davis, Fort Randolph, Fort San Lorenzo, Fort Sherman, France Field, Loma Boracho (biting man), Mindi Dairy, Mojinga Swamp.

DISCUSSION: *Culicoides gorgasi* Wirth and Blanton and *C. barbosai* Wirth and Blanton are closely related to this species but they have a distinct wing pattern; *gorgasi* also differs from *alahialinus* in having

a more distinct mesonotal pattern with a yellowish median area and by its larger size, while *barbosai* also differs in having sensoria on antennal segment VII.

57. *Culicoides barbosai* Wirth and Blanton

FIGURE 60

Culicoides barbosai Wirth and Blanton, 1956, Florida Ent., vol. 39, p. 161 (male, female; Panama, Florida, Bahamas, Ecuador; fig. wing, mesonotum, tibial comb, spermathecae, male genitalia).

FEMALE: Length of wing 0.88 (0.83–0.92, $n=5$) mm.

Head.—Eyes nearly contiguous, bare. Antenna with flagellar segments in proportion of 18:13:13:13:13:13:13:15:18:20:20:28, antennal ratio 0.93 (0.92–0.95, $n=3$); distal sensory tufts present on segments III, VII–X, rarely absent on VII. Palpal segments in propor-

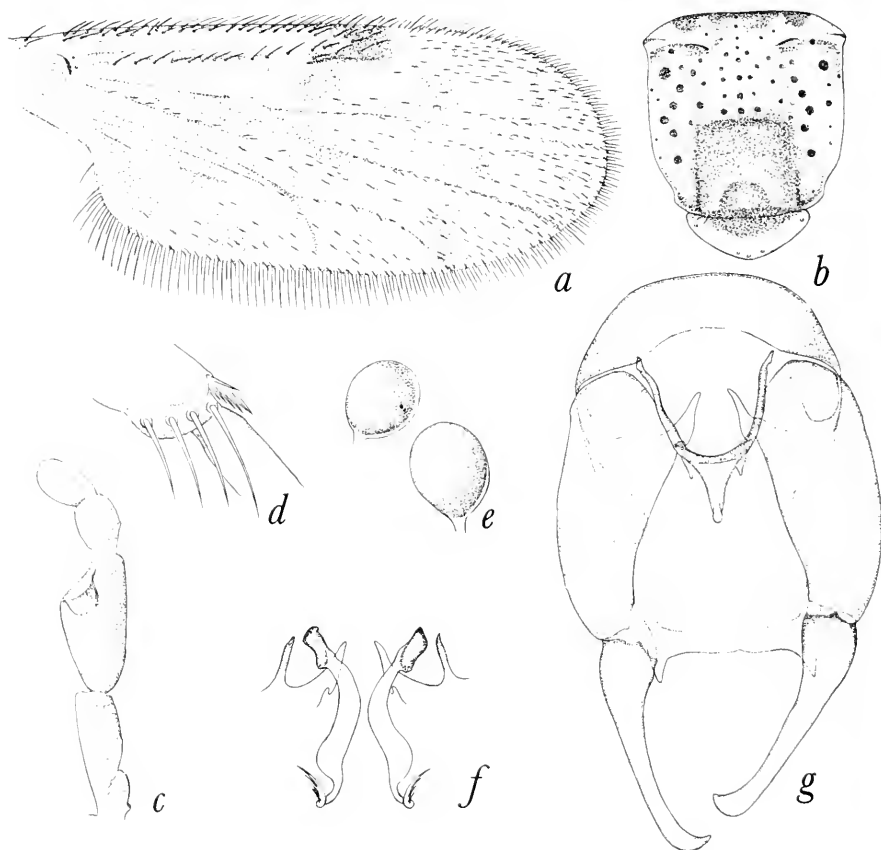


FIGURE 60.—*Culicoides barbosai* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

tion of 9:17:21:8:8, third segment moderately swollen, 2.2 (1.8–2.3, $n=3$) times as long as greatest breadth, with a small, deep sensory pit.

Thorax.—Mesonotum pruinose gray with pattern of dark brown punctiform dots at bases of mesonotal hairs, these dots irregularly fused in some areas, principally in two sublateral, longitudinal bands. Scutellum narrowly dark in middle, yellowish on sides. Postscutellum and pleuron dark brown. Legs dark brown; knee spots blackish, all femora with subapical, all tibia with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=5$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, large yellowish anterior spots at wing base and over r-m crossvein; two longitudinally elongate poststigmatic pale spots in cell R_5 , narrowly fused to form an hourglass-shaped spot; distal pale spot in cell R_5 large, rounded and broadly meeting anterior wing margin; two pale spots in cell M_1 , the proximal one streaklike and lying adjacent to vein M_2 , the distal one usually connected by a narrow pale line to wing margin; veins M_1 and M_2 very faintly pale margined on distal halves; a pale line running through cell M_2 to the pale spot at apex of cell M_2 ; large pale spot in cell M_4 ; two pale spots, more or less coalesced, in distal part of anal cell. Macrotrichia numerous on distal half of wing and a few in anal cell; costa extending to 0.58 (0.57–0.59, $n=5$) of distance to wing tip. Halter dark.

Abdomen.—Dark brown, cerci pale. Spermathecae two, subequal, each measuring 0.045 by 0.030 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with broad caudomedian excavation; ninth tergum long, the apicolateral processes moderately long and slender. Basistyle with slender, foot-shaped ventral root, dorsal root slender; dististyle long and very slender, with bent apex. Aedeagus with basal arch extending to about 0.7 of total length of aedeagus, basal arms slender and slightly curved, distal portion tapered to slender, rounded point with an indistinct lateral pair of pointed hyaline processes near juncture with the arch. Parameres each with strongly sclerotized basal knob, stem slender and curved near base, distal portion gradually more swollen, until there arises a distinct low ventral lobed area beyond which the distal portion is quite slender, tapering to fine point with a few minute lateral barbs.

DISTRIBUTION: Panama; Bahamas; United States (Florida).

PANAMA RECORDS:

CANAL ZONE: Balboa (Apr. 28, 1942, P. A. Woke, biting man; including 3 paratypes of *wokei* Barbosa not Fox); Fort Randolph, Fort Sherman, Loma Boracho, Mojinga Swamp (type locality).

DISCUSSION: Like the closely related *alahialinus* Barbosa, this species is apparently restricted in Panama to localities with saline

environments in the Canal Zone. It superficially resembles *furens* (Poey) in wing and mesonotal markings but the relationship to *furens* is not so close as to *alahialinus* and *gorgasi* Wirth and Blanton. *Culicoides alahialinus* differs in having a very faint wing pattern and fainter mesonotal pattern and lacking the sensoria on segment VII of the antenna; *gorgasi* differs in its larger size, more prominent mesonotal pattern with yellowish center and also lacking the sensoria on antennal segment VII. *Barbosai* at times is fairly abundant at some localities in the Bahamas and extreme southern Florida, where it has been confused with *furens*.

58. *Culicoides gorgasi* Wirth and Blanton

FIGURE 61

Culicoides gorgasi Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 232 (male, female; Panama; fig. wing, mesonotum, palpus, male genitalia).

FEMALE: Length of wing 1.04 (0.96–1.09, $n=10$) mm.

Head.—Eyes nearly contiguous, bare. Antenna with flagellar segments in proportion of 23:17:17:17:17:16:16:16:24:24:26:26:37, antennal ratio 0.99 (0.94–1.03, $n=5$); distal sensory tufts present on segments III, VIII–X, rarely on VII. Palpal segments in proportion of 9:24:25:10:12, third segment moderately swollen, 2.1 (1.9–2.4) times as long as broad, with a small, deep sensory pit. Mandible with 17 (15–19, $n=12$) teeth.

Thorax.—Mesonotum pruinose gray-brown with prominent pattern on dark brown punctiform dots at bases of mesonotal hairs, these dots irregularly fused in some areas, principally in two sublateral longitudinal bands; an elongate pair of submedian anterior spots yellowish brown. Scutellum narrowly brown in middle, dark brown on sides; postscutellum and pleuron dark brown. Legs dark brown; knee spots blackish; all femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; large yellowish areas at wing base and over r-m crossvein; two longitudinal, elongate poststigmatic pale spots in cell R_5 , the anterior one situated entirely distad of the posterior one and sometimes connected to it by a very narrow pale space, distal pale spot in cell R_5 usually narrowly connected obliquely distad to anterior wing margin; two small, narrow, elongate pale spots in cell M_1 , the distal one sometimes connected by a narrow pale line to a trace of a small pale spot at wing margin; a large pale spot at wing margin in cell M_2 and one in cell M_4 ; two pale spots in distal portion of anal cell; cell M with a pale line from base connected to a pale spot behind medial fork and a pale spot lying ahead of broadest portion of cell M_4 . Macrotrichia numerous on distal portion of wing and in anal cell and

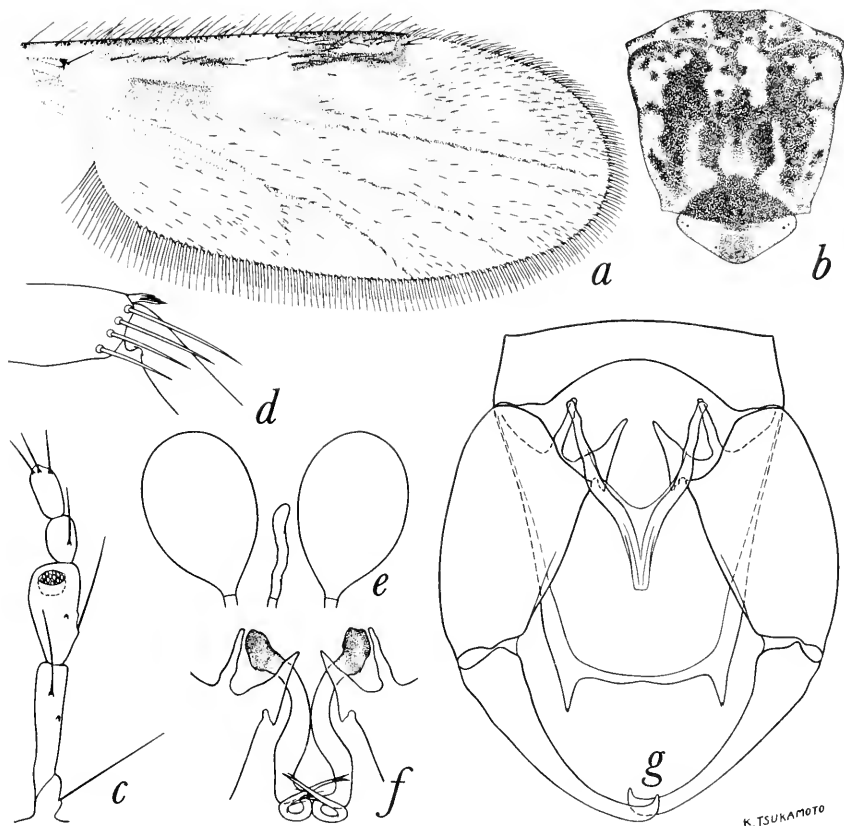


FIGURE 61.—*Culicoides gorgasi* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

extending nearly to base of cell M; costa extending to 0.64 (0.61–0.67, $n=10$) of distance to wing tip. Halter knob infuscated.

Abdomen.—Dark brown, cerci pale. Spermathecae two, ovoid, slightly unequal, measuring 0.054 by 0.039 mm. and 0.049 by 0.036 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA.—Ninth sternum with broad, shallow, caudomedian excavation; ninth tergum long with long, triangular, apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel well developed, dorsal root slender; dististyle long and slender with hooked apex. Aedeagus with basal arch extending to three-fourths of total length of aedeagus, basal arms well sclerotized and nearly straight, the basal arch narrow caudomedially; distal portion short and simple, with moderately broad, truncate apex, the subapical, lateral points at

junction with the arch poorly sclerotized. Parameres each with large basal knob, stem slender and gradually curved near base, broadened and bowed ventrally in distal portion forming a very low ventral swelling, the slender distal portion very abruptly bent and twisted before turning ventrad and ending in a fine point bearing several fine subapical hairs.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CANAL ZONE: Galeta Point, Mojinga Swamp.

COCLÉ PROVINCE: Aguadulce, Puerto Farallón, Río Hato.

DARIÉN PROVINCE: Garachiné, Jaqué, Punta Patiño.

HERRERA PROVINCE: Puerto Chitré.

LOS SANTOS PROVINCE: Las Tablas (type locality), Puerto Mensabé.

PANAMÁ PROVINCE: Bayano, Isla Taboga, Pedregal.

DISCUSSION: This species is closely related to *alahialinus* Barbosa and *barbosai* Wirth and Blanton, which are smaller with much more obscure mesonotal pattern; the first species also with very faint wing pattern and the second differing in having sensoria on the seventh antennal segment. These species also differ significantly in the shape of the male parameres and apicolateral processes of the ninth tergum.

Culicoides gorgasi, like *furens* (Poey), which it superficially resembles to a remarkable degree, is widespread in Panama in mangrove salt marshes, but unlike *furens* its greatest abundance is reached in localities on the Pacific coasts of Darién, Coclé, and Los Santos Provinces.

59. *Culicoides furens* (Poey)

FIGURES 3, 62

Oecacta furens Poey, 1853, Mem. Hist. Nat. Isla de Cuba, vol. 1, p. 236 (female; Cuba; fig. female, wing, head, antenna, mouthparts).

Culicoides furens, Lutz, 1912, Mem. Inst. Oswaldo Cruz, vol. 4, p. 16.—Hoffman, 1925, Amer. Journ. Hyg., vol. 5, p. 287.—Macfie, 1937, Ann. Mag. Nat. Hist., ser. 10, vol. 20, p. 10 (male, female; Trinidad; fig. male genitalia; synonyms, *dovei* Hall, *maculithorax* Williston).—Root and Hoffman, 1937, Amer. Journ. Hyg., vol. 25, p. 162 (male, female; United States; fig. male genitalia).—Barretto, 1944, Anais Fac. Med. Univ. Sao Paulo, vol. 20, p. 89 (male; Brazil; fig. wing, palpus, antenna and genitalia of male).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 15 (distribution and notes; fig. male genitalia).—Wirth, 1952, Florida Ent., vol. 35, p. 91 (Florida; fig. larva, pupa).—Foote and Pratt, 1954, Pub. Health Monogr., vol. 18, p. 21 (male, female; United States records; fig. wing, mesonotum, palpus, male genitalia).—Ortiz and Leon, 1955, Bol. Inf. Cient. Nac., no. 67, p. 572 (female; Ecuador; fig. wing, palpus).—Wirth and Blanton, 1956, Florida Ent., vol. 39, p. 159 (redescription, distribution, figs.).

Ceratopogon maculithorax Williston, 1896, Trans. Ent. Soc. London, vol. 3, p. 277 (female; St. Vincent; fig. wing).—Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 53 (male, female; Brazil; fig. wing).—Floch and Abonnenc, 1942, Inst. Pasteur Guyane Terr. l'Inini, publ. 49, p. 1 (female; Guadeloupe; fig. wing, palpus).

Culicoides dovei Hall, 1932, Proc. Ent. Soc. Washington, vol. 34, p. 88 (male, female; Georgia; fig. male genitalia); Dove, Hall and Hull, 1932, Ann. Ent. Soc. Amer., vol. 25, p. 505 (biology, United States; fig. all stages).

FEMALE: Length of wing 0.91 (0.88–0.99, $n=16$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:12:12:12:12:12:12:20:22:24:25:35, antennal ratio 1.28 (1.09–1.51, $n=7$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 11:24:28:10:13, third segment slightly swollen, 2.4 (2.1–2.9, $n=16$) times as long as greatest breadth, with a small, shallow, sensory pit. Mandible with 15 (12–17, $n=16$) teeth.

Thorax.—Mesonotum pollinose grayish, with a prominent pattern consisting of numerous, evenly scattered, punctiform brown dots at the seta bases. Scutellum brown in middle, grayish pruinose on sides; postscutellum and pleuron dark brown. Legs brown, knee spots blackish; femora pale at bases, femora with subapical, tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=15$) spines, the one next to the spur longest.

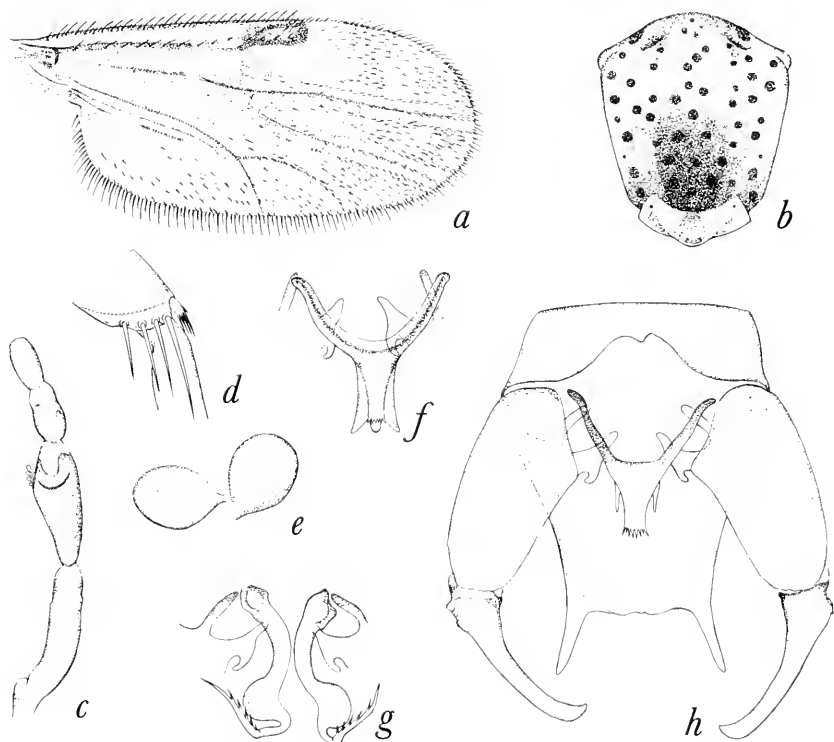


FIGURE 62.—*Culicoides furens* (Poey). a–e, Female: a, wing; b, thoracic pattern; c, palpus; d, tibial comb; e, spermathecae. f–h, Male: f, aedeagus, variation; g, parameres; h, genitalia, parameres removed.

Wing.—Pattern as figured; second radial cell blackish; pale spot over r-m crossvein quite broad; cell R_5 with three small round post-stigmatic spots in a triangle, the two next to the second radial cell more or less fused, a large, oblique, double spot broadly meeting wing margin in distal part of cell; vein M_1 pale margined from apex nearly to its base, veins M_2 and M_{3+4} pale margined on distal portions; cell M_1 with three pale spots, the distal one located at the wing margin; cell M_2 with two pale spots in distal part, the distal one broadly meeting wing margin; cell M_4 with a large pale spot; two small round pale spots in distal part of anal cell; pale area at base of anal cell narrowly connected to the large pale area over wing base; pale spot present in cell M_2 behind medial fork. Macrotrichia fairly numerous on distal half of wing and in anal cell; costa extending to 0.58 (0.56–0.61, $n=16$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, pyriform, subequal, each measuring 0.057 by 0.037 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with broad, deep, caudomedian excavation; ninth tergum markedly tapering with very long, slender, pointed, apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root slender; dististyle slender, slightly curved, with bent, pointed tip. Aedeagus with very broad, rounded, basal arch extending to about half of total length, the basal arms evenly curved; distal portion of two types: in one the very slender, median, distally striate tip is flanked by a prominent pair of lateral points of about the same length; in the other type, the lateral points are apparently lacking and the striated median tip is broader. Parameres each with basal knob large, stem moderately stout and curved, bearing an extremely large ventral lobe; distal portion tapering to a fine point and bearing about five strong lateral barbs.

DISTRIBUTION: Cuba; Atlantic and Gulf Coasts of United States from Massachusetts to Florida and Texas, Caribbean and Atlantic Coasts of Central America and West Indies to Brazil, Pacific Coast from Mexico to Ecuador.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Balboa, Corozal (S. T. Darling, 1912), Farfan Beach (C. L. Pierce, 1944), Fort Gulick, Fort Kobbe, Fort San Lorenzo, Fort Sherman, France Field, Galeta Point, Huile Sia Clara(?), Loma Boracho, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Alanje, Algarrobo, Boca Chica, Chiriquí, David, Gualaca, Horconcitos, Río Tabasará, Tortugas.

COCLÉ PROVINCE: Aguadulce, Antón, Chirú, El Barrero, El Cristo, El Retiro, El Salado, Espiño, Natá, Pocrí, Puerto Farallón, Puerto Obaldía, Puerto Posado, Río Hato.

COLÓN PROVINCE: Cativá, Piña, Salud.

DARIÉN PROVINCE: Garachiné, Jaqué, Punta Patiño.

HERRERA PROVINCE: Ocú, Puerto Chitré.

LOS SANTOS PROVINCE: Guararé, La Palma, Peña Blanca, Puerto Mensabé, Río Estibaná, San José, Santo Domingo.

PANAMÁ PROVINCE: Arraiján, Bayano, Camarón, Capitana, Chepo, El Espino, La Jolla, Pacora, Panamá Vieja, Pedregal, Río Las Lajas, San Carlos, Tocumen, Viqué Cove.

VERAGUAS PROVINCE: Divisa.

ARCHIPIÉLAGO DE LAS PERLAS: Isla del Rey.

DISCUSSION: Except for the differences in the tip of the aedeagus, this widely distributed and abundant salt marsh species is fairly constant in its characters. Males from the United States, Bahamas, and from most of the Panama localities have the lateral apical points of the aedeagus lacking, while males from Trinidad and from Aguadulce, Garachiné, Puerto Mensabé, and Tocumen and part of the series from Río Hato have these points well developed. The latter form might well prove to be a subspecies for which the name *maculithorax* (Williston) is available, but a distributional study of males from many Caribbean localities would be necessary to establish this relationship.

The *fluvialis* group

This group consists of small to medium-sized species with prominent mesonotal pattern, wing pattern usually of definite small pale spots, vein M_1 pale-margined distally or the apices of veins M_1 , M_2 and sometimes M_{3+4} pale; female antenna with sensoria present on segments III, VII or VIII to X and rarely to XI or XIV; four tibial spines; one or two spermathecae; male genitalia with ventral root of basistyle foot-shaped, paramere with simple basal knob, stem short, with or without ventral lobe, the apex fringed or simple; aedeagus usually with simple tip.

PANAMA SPECIES: Six: *balsapambensis* Ortiz and Leon, *castillae* Fox, *fluvialis* Macfie, *leopoldoi* Ortiz, *propriipennis* Macfie, and *tetrathyris*, new species.

60. *Culicoides fluvialis* Macfie

FIGURE 63

Culicoides fluvialis Macfie, 1940, Ent. Monthly Mag., vol. 76, p. 75 (female; British Guiana; fig. wing).—Ortiz, 1951, Nov. Cient. Mus. Hist. Nat. LaSalle, zool. ser., no. 5, p. 2 (female; Venezuela; fig. wing, palpus, spermathecae); 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 264 (male; Venezuela; fig. wing, palpus, genitalia, fig. female wing).

FEMALE: Length of wing 0.76 (0.73–0.79, $n=10$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 15:11:11:11:11:12:12:12:17:18:18:19:29, antennal ratio 1.07 (1.05–1.11, $n=6$); distal sensory tufts present on

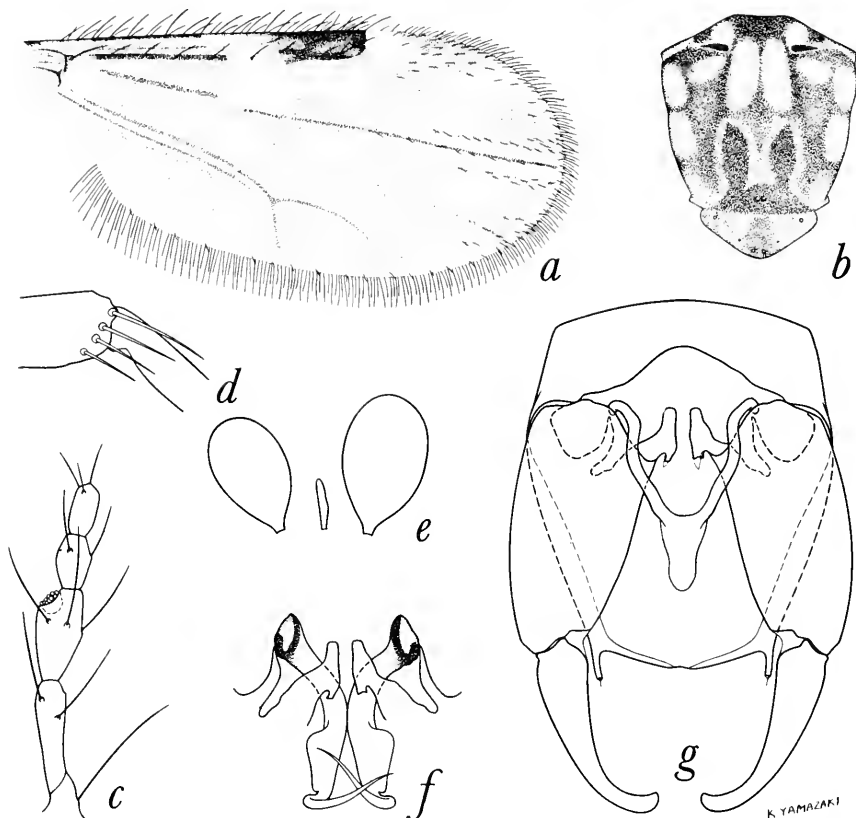


FIGURE 63.—*Culicoides fluviatilis* Macfie. *a-e*, Female; *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male; *f*, parameres; *g*, genitalia, parameres removed.

segments III, VIII-X. Palpal segments in proportion of 6:15:16:7:7, third segment short and slightly swollen, 1.8 (1.7-1.9, $n=9$) times as long as greatest breadth, with a small, deep sensory pit. Mandible with 13 (12-15, $n=7$) teeth.

Thorax.—Mesonotum grayish pruinose, blackish between the humeral pits, with a prominent pattern consisting mainly of a sub-lateral pair of brown bands, widest at level of the lateral suture, leaving a median anterior pair of elongated yellowish gray spots. Scutellum brown in middle, yellowish gray on sides; postscutellum and pleuron dark brown. Legs brown; knee spots blackish; all femora with subapical and all tibiae with subbasal narrow pale rings; femora pale at bases; hind tibial comb with four ($n=7$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell moderately dark; a small pale spot over r-m crossvein; cell R_5 with two separate, round, poststigmatic pale spots, the posterior one located behind second

radial cell; distal pale spot in cell R_5 hourglass-shaped, oblique, broadly meeting wing margin; apices of veins M_1 and M_2 with a small pale spot at wing margin; cell M_1 with two pale spots, the distal one located far from wing margin; two distal pale spots in cell M_2 , the apical one located at the wing margin; cell M_4 with a round pale spot almost meeting wing margin; only one small round pale spot in distal part of anal cell; cell M_2 with no pale spot lying in front of medio-cubital fork, a small pale spot present lying behind medial fork. Macrotrichia sparse and in rows on distal fourth of wing in cells R_5 , M_1 and M_2 ; costa extending to 0.61 (0.59–0.62, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Dull blackish. Spermathecae two, oval, slightly unequal, measuring 0.046 by 0.029 mm. and 0.040 by 0.026 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with a moderately deep caudo-median excavation; ninth tergum broad apically with long, extremely slender, apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root short and slender; dististyle slender and markedly curved to pointed tip. Aedeagus with broad, pointed basal arch extending to two-thirds of total length, the basal arms slender and curved; distal portion short and stout with bluntly rounded tip. Parameres each with large basal knob, stem stout, markedly bent at mid-portion, the part distad stout with a low, flat, extensive, ventral lobe, the apex narrowed to simple sharp point.

DISTRIBUTION: British Guiana; Honduras (Lancetilla); Panama; Venezuela.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Sherman, Loma Boracho, Mojinga Swamp.

PANAMÁ PROVINCE: Isla Taboga.

DISCUSSION: Ortiz (1954) has described *fernandezi* from Venezuela, a species very similar to *fluvialis* but differing mainly in having the poststigmatic pale spots in cell R_5 narrowly fused, lacking the pale spot at wing margin at the apex of vein M_2 , having a pale spot present in front of the medio-cubital fork, having sensoria present on segments III, VII-X and being slightly larger, wing 1.0 mm. long.

61. *Culicoides tetrathyris*, new species

FIGURE 64

FEMALE: Length of wing 0.85 (0.69–0.87, $n=12$) mm.

Head.—Eyes nearly contiguous, bare. Antenna with flagellar segments in proportion of 15:12:13:14:14:14:14:14:19:20:21:20:34, antennal ratio 1.09 (1.04–1.14, $n=4$); distal sensory tufts present on

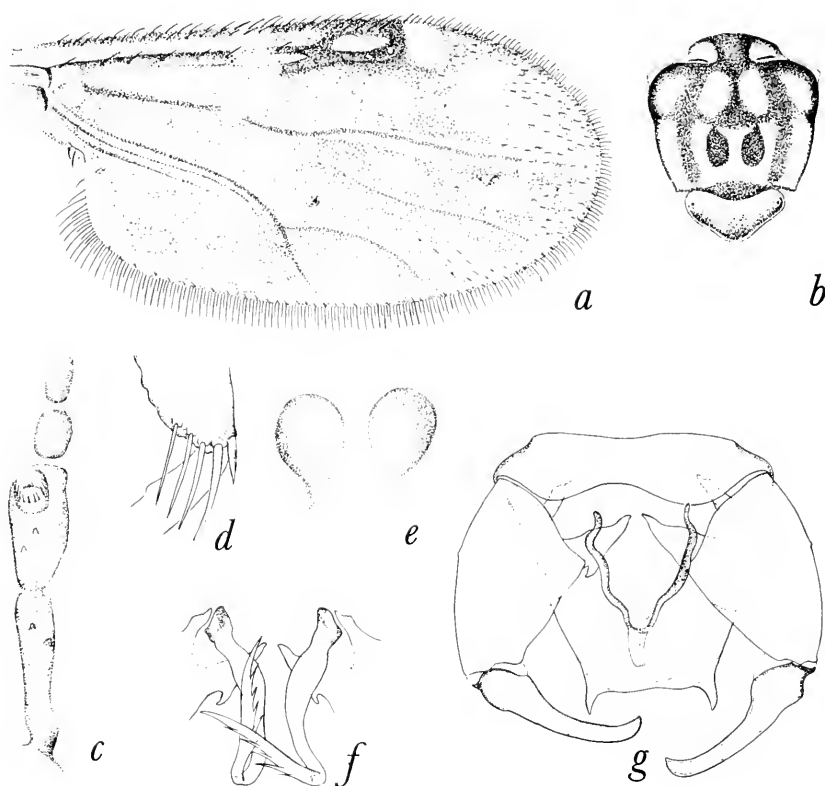


FIGURE 64.—*Culicoides tetrathyris*, new species. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

segments III, VIII-X. Palpal segments in proportion to 7:21:22:9:9, third segment moderately swollen to apex, 1.9 (1.5-2.1, $n=12$) times as long as greatest breadth, with a moderately large and deep sensory pit. Mandible with 14 (12-15, $n=13$) teeth.

Thorax.—Mesonotum blackish, with a prominent pattern of pruinose bluish gray patches as figured, the submedian anterior pair yellowish when viewed from above and behind. Scutellum narrowly dark brown in middle, sides broadly pale yellowish; postscutellum and pleuron blackish. Legs blackish; fore and mid femora with subapical, and all tibiae with sub-basal, narrow whitish rings; hind tibial comb with four (4-5, $n=12$) long spines, the one next to the spur longest, a third as long as basitarsus.

Wing.—Pattern as figured, cell R_5 with four small, round, pale spots arranged in a trapezoid, two pale spots each in cell M_1 and apex

of anal cell, only one pale spot in distal portion of cell M_2 , a pale spot behind medial fork and another in front of mediocubital fork, ends of veins M_1 , M_2 and M_{3+4} with pale spot at wing margin. Macrotrichia sparse on distal fourth of wing; costa extending to 0.70 of distance to wing tip. Halter pale.

Abdomen.—Blackish, cerci yellowish. Spermathecae two, subequal, pyriform, each measuring 0.045 by 0.030 mm.

MALE GENITALIA: Ninth sternum with small but distinct caudomedian excavation; ninth tergum tapering, the apicolateral processes moderately long with slender points. Basistyle with ventral and dorsal roots of subequal lengths, the ventral root foot-shaped with distinct heel and long toe; dististyle slender, curved to pointed apex. Aedeagus with high basal arch, the mesal apex of arch narrow; distal stem slender with rounded point. Parameres each with knobbed base, swollen toward base of stem, stem abruptly bent at base but straight in midportion, ventral lobe absent, distal portion somewhat flattened with lateral fringe of sharp barbs, tapering to a needle-like point.

DISTRIBUTION: Panama; Honduras.

SPECIMENS EXAMINED: Holotype female (USNM 63169), allotype male, Almirante, Bocas del Toro Province, Panama, November 1952, F. S. Blanton, light trap. Paratypes, 19 males, 80 females: PANAMA: Bocas del Toro Province: 8 males, 49 females, same data as type except dates October 1952 to March 1953. Canal Zone: 2 males, 1 female, Fort Davis, Oct. 7, 1953; 2 females, Loma Boracho, Oct. 29, 1951; 1 male, 1 female, Mindi Dairy, Dec. 17, 1951, Aug. 22, 1952; 2 males, 4 females, Mojinga Swamp, Jan. 2, Sept. 4, Dec. 4, 1951. Coclé Province: 1 female, Penonomé, Nov. 28, 1952; 1 female, Río Hato, Sept. 24, 1951. Panamá Province: 1 female, Pacora, June 4, 1951. HONDURAS: 5 males, 20 females, Lancetilla, July 2, 1953 to Feb. 12, 1954, P. Galindo; 1 male, Tela, June 10, 1953, P. Galindo.

DISCUSSION: This species closely resembles *propriipennis* Macfie in wing pattern, mesonotal and leg markings, structural characters, and male genitalia, but *propriipennis* differs by having the sides of the mesonotum brownish instead of bluish pruinose, a third pale spot in cell M_1 at the wing margin, the pale spots in cell R_5 arranged in a rhomboid instead of a trapezoid, distal sensory tufts on antennal segments III, IX-XIV, and the pit on the third palpal segment broader. The male genitalia of the two species are practically identical, but in *propriipennis* the stem of the paramere is stouter and not bent near the base.

62. *Culicoides propriipennis* Macfie

FIGURE 65

Culicoides propriipennis Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 84 (female; Chiapas, Mexico; fig. wing).—Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 262 (male; Venezuela; fig. wing, palpus, genitalia).—Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 116 (male, female; Guatemala; fig. palpus, male genitalia).

FEMALE: Length of wing 0.85 (0.79–0.89, $n=8$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 16:11:13:14:14:14:14:15:19:19:20:20:32, antennal ratio 0.97 (0.91–1.02, $n=4$); distal sensory tufts present on segments III, VIII–XIV. Palpal segments in proportion of 8:18:20:9:9, third segment slightly swollen, 1.9 (1.7–2.1, $n=8$) times as long as greatest breadth, with a very broad, shallow, sensory pit. Mandible with 15 (15–16, $n=4$) teeth.

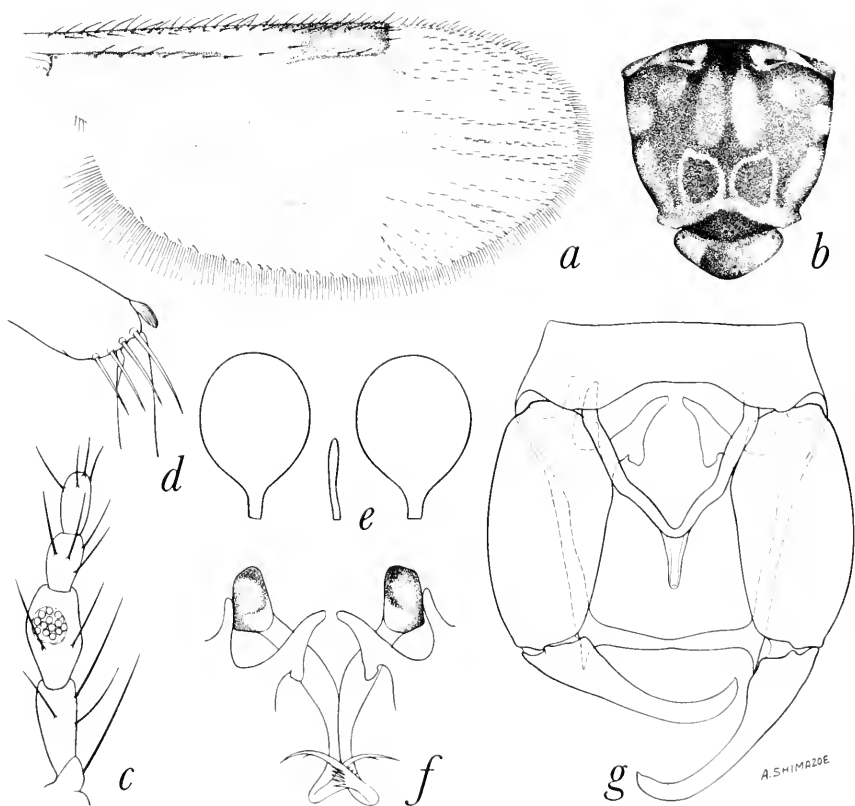


FIGURE 65.—*Culicoides propriipennis* Macfie. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum dark brown with a prominent pattern of pale spots and patches; a submedian anterior pair of elongate yellowish spots and several smaller pruinose yellowish gray spots around lateral margins. Scutellum dark brown in middle, yellowish on sides; postscutellum and pleuron dark brown, pleuron yellowish above. Legs dark brown, fore and mid femora with subapical and all tibiae with subbasal, narrow pale rings; hind tibial comb with four ($n=6$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell very dark; pale spot over r-m crossvein extensive; cell R_5 with four small well-separated round pale spots distributed in a rhomboidal pattern, the two anterior spots situated distad of the posterior ones; apex of vein M_1 with a pale spot at wing margin; three pale spots in cell M_1 , the distal one located at the wing margin and sometimes faint; two pale spots in distal part of cell M_2 ; small round pale spot in center of cell M_4 ; two well-separated, small round pale spots in distal part of anal cell, a faint, irregular, pale area at base of anal cell; cell M_2 with a pale spot lying behind medial fork, one lying in front of mediocubital fork and a faint one near base of cell; a pale area distad of basal areculus. Macrotrichia sparse on distal third of wing; costa extending to 0.63 (0.62–0.65, $n=8$) of distance to wing tip. Halter with base of knob brownish.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, ovoid, subequal, measuring 0.055 by 0.039 mm. and 0.050 by 0.031 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with a broad caudomedian excavation; ninth tergum short and tapered, with short apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root short and tapered; dististyle slender and curved with bent tip. Aedeagus V-shaped, the basal arch pointed caudad, extending to three-fourths of total length, the basal arms straight, the posterior portion slender with simple tip. Parameres each with large basal knob, stem slender near base, slightly swollen in midportion, gradually tapered distally to slender tip with a subapical fringe of spines, the portion at the base of the fringe slightly expanded.

DISTRIBUTION: Mexico; Guatemala; Nicaragua (Villa Somoza); Venezuela.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante,

CANAL ZONE: Fort San Lorenzo, Huile Sia Clara (?), Loma Boracho, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Concepción.

COCLÉ PROVINCE: Penomóné.

DARIÉN PROVINCE: Garachiné.

PANAMÁ PROVINCE: Pacora.

DISCUSSION: This species is closely related to *tetrathyris*, new species, but *propriipennis* can easily be distinguished by the presence of a third pale spot at the wing margin in cell M_1 , by the second pale spot in the distal portion of cell M_2 , and by the presence of distal sensory tufts on segments XI–XIV as well as on III, VIII–X.

63. *Culicoides balsapambensis* Ortiz and Leon, new status

FIGURE 66

Culicoides pifanoi var. *balsapambensis* Ortiz and Leon, 1955, Bol. Inf. Cient. Nac. Ecuador, no. 67, p. 579 (female; Balsapamba, Bolívar, Ecuador; fig. wing, palpus).

FEMALE: Length of wing 0.72 (0.66–0.76, $n=5$) mm.

Head.—Eyes narrowly separated, with long interfacetal hairs. Antenna with flagellar segments in proportion of 15:12:12:14:14:13:14:15:15:15:16:17:26, antennal ratio 0.84 (0.81–0.86, $n=2$); distal sensory

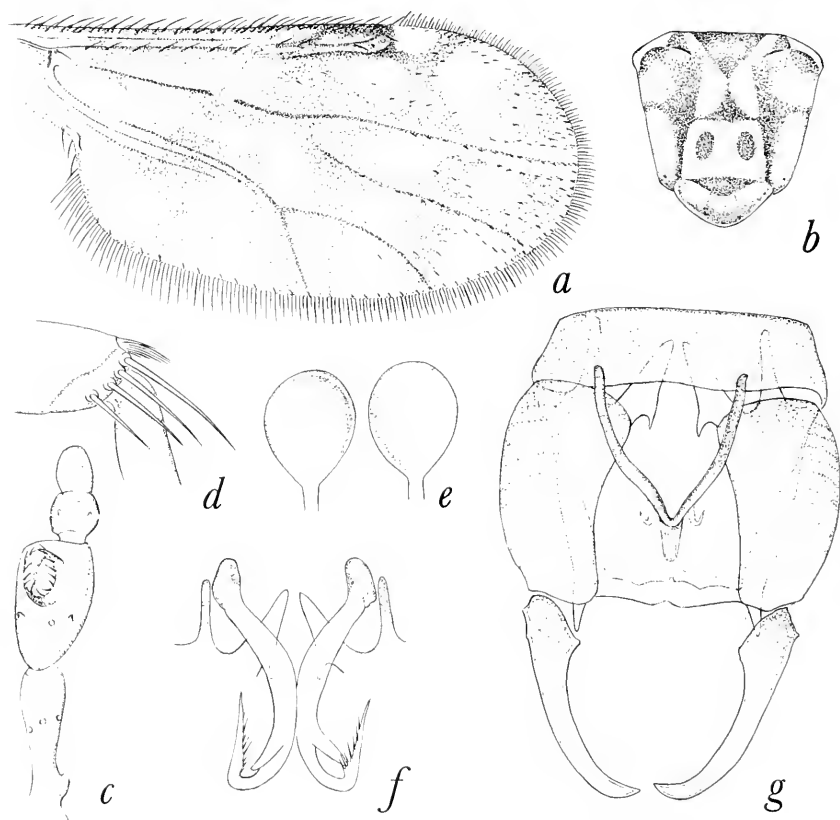


FIGURE 66.—*Culicoides balsapambensis* Ortiz and Leon. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

tufts present on segments III, VIII-X. Palpal segments in proportion of 6:17:20:7:7, third segment moderately swollen, 1.8 (1.7-1.9, $n=6$) times as long as greatest breadth, with broad, deep, sensory pit. Mandible with 14 (13-14, $n=5$) teeth.

Thorax.—Mesonotum bluish gray pollinose, with two prominent, jet black, sublateral, longitudinal patches, widest at the mesonotal suture. Scutellum narrowly dark brown in middle, pale on sides; postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=5$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale spot over r-m crossvein large and meeting anterior wing margin; poststigmatic pale spots in cell R_5 small, distinctly separated, the posterior one located slightly proximad of the anterior one, its diameter longest in the longitudinal axis of wing; distal pale spot in cell R_5 reniform, broadly meeting anterior wing margin anterodistad; vein M_1 pale-margined on distal half; two pale spots in cell M_1 , the distal one far removed from wing margin; two pale spots in distal portion of cell M_2 , connected narrowly by a pale line bordering posterior margin of vein M_2 ; pale spot in cell M_4 large; two pale spots in distal portion of anal cell; pale spots present in front of mediocubital fork and behind medial fork, base of wing pale from costal margin to the proximal fourth of anal cell. Macrotrichia very sparse on distal fourth of wing and extending along posterior margin to distal part of cell M_4 ; costa extending to 0.70 (0.68-0.72, $n=5$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, slightly unequal, ovoid, measuring 0.048 by 0.031 mm. and 0.045 by 0.028 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum short, very broad and truncate apically with slender apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel sharp, the toe long and pointed, dorsal root slender; dististyle long and slender, markedly curved to a pointed apex. Aedeagus with basal arch extending to three-fourths of total length, pointed at mesal apex, the basal arms curved; distal apex simple, with slender, rounded point. Parameres each with well-developed basal knob, stem gradually curved to the well-developed, pointed, ventral lobe, distal portion slender and tapered to apical point with a lateral fringe of fine barbs.

DISTRIBUTION: Ecuador; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Loma Boracho.

DISCUSSION: The resemblance of this species to *pifanoi* Ortiz, which led Ortiz and Leon to describe it as a variety of that species, is only a superficial one of the wing and mesonotal markings. The wing markings are much more like those of *castillae* Fox, differing only in the broad extension of the distal pale spot in cell R_5 to the wing margin, while the presence of only one spermatheca in *castillae* provides an additional quick separation.

64. *Culicoides castillae* Fox

FIGURE 67

Culicoides castillae Fox, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 251 (female; Puerto Castilla, Honduras; fig. mesonotum, wing).

Culicoides dasyophrus Barbosa (misident., not *dasyophrus* Macfie), 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 14 (Panama; fig. male genitalia).

Culicoides lichyi Ortiz and Mirsa (misident., not Floch and Abonnenc), 1951, Rev. Sanid. Asist. Soc., vol. 16, p. 601 (female; Venezuela; fig. mesonotum, palpus, spermatheca, wing).

Culicoides flochabonnenci Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 267 (female; Venezuela; fig. palpus, spermatheca, wing).—Ortiz, 1953, idem., vol. 18, p. 801 (in key).—Ortiz and Leon, 1955, Bol. Inf. Cient. Nac. Ecuador, no. 67, p. 574 (male, female; Ecuador; fig. wing, palpus, spermatheca, antenna). New synonymy.

Culicoides gibsoni Wirth, 1952, Journ. Parasit., vol. 38, p. 246 (female; Guatemala; fig. wing, palpus, spermatheca); 1955, Proc. Ent. Soc. Washington, vol. 57, p. 111 (Guatemala; male, female; fig. male Genitalia). New synonymy.

FEMALE: Length of wing 0.84 (0.79–0.89, $n=9$) mm.

Head.—Eyes moderately separated, with short interfacetal hairs. Antenna with flagellar segments in proportion of 15:10:12:12:13:13:13:14:18:19:21:22:30, antennal ratio 1.09 (1.02–1.15, $n=9$); distal sensory tufts present on segments III, VIII–XI. Palpal segments in proportion of 6:18:22:7:8, third segment slightly swollen, 2.2 (2.0–2.3, $n=10$) times as long as greatest breadth, with a small, shallow, sensory pit. Mandible with 15 (14–16, $n=7$) teeth.

Thorax.—Mesonotum very dark brown with a prominent pattern as figured, the submedian elongate spots yellowish, the sublateral bands intense black. Scutellum brown in middle, yellowish on sides. Legs dark brown, fore and mid femora with subapical, and all tibiae with subbasal, narrow white rings; hind tibial comb with four ($n=9$) spines, the one nearest the spur longest, a third as long as basitarsus.

Wing.—Pattern as figured, the three pale spots in cell R_5 arranged in a triangle and well separated, the distal spot often irregularly V-shaped; distal half of vein M_1 pale-margined, two pale spots in cell M_1 and in apices of cells M_2 and anal cell. Macrotrichia sparse in apices of cells R_5 , M_1 and M_2 ; costa extending to 0.64 of distance to wing tip. Halter pale, base of the knob darkened.

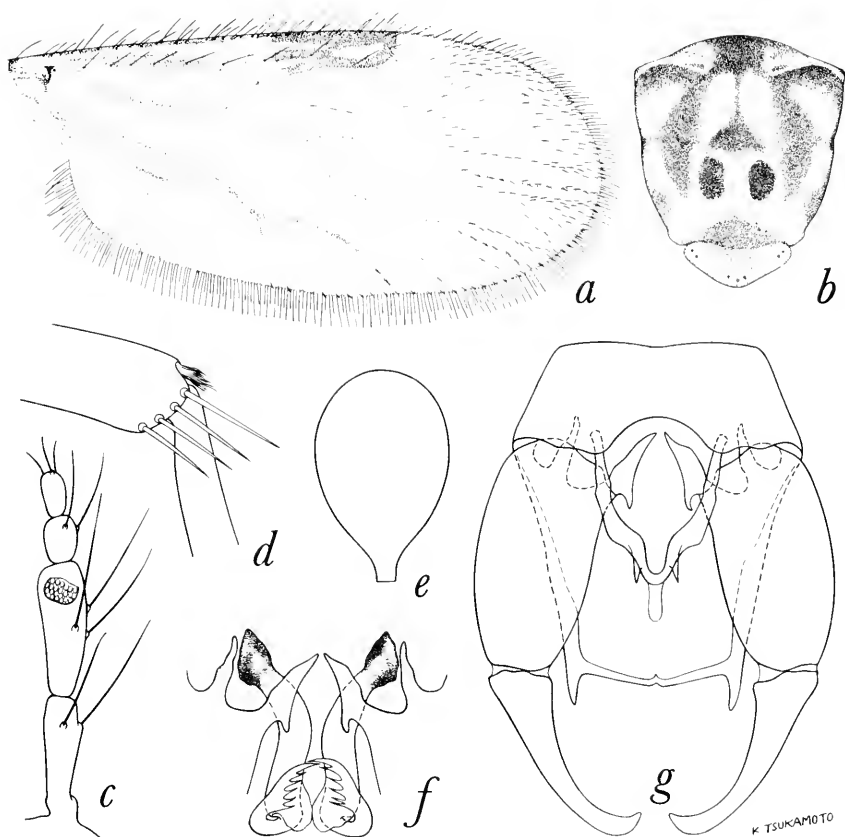


FIGURE 67.—*Culicoides castillae* Fox. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermatheca. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Abdomen.—Dull brownish black. Spermatheca one, pyriform, the base of the duct sclerotized, spermatheca measuring 0.052 by 0.037 mm.

MALE GENITALIA: Ninth sternum with shallow caudomedian excavation; ninth tergum tapering, with short, pointed, apicolateral processes. Basistyle with ventral root foot-shaped with a distinct posterior heel; dististyle slender and slightly curved to pointed apex. Aedeagus with basal arch extending to two-thirds of total length, basal arms curved and slender, posterior stem slender and pointed, with a pair of subapical projections arising on sides at juncture with the arch. Parameres each with knobbed base, stem slightly swollen and distinctly bent at midlength, with a small ventral lobe and apex pointed with a fringe of fine barbs.

DISTRIBUTION: Honduras; Ecuador; Guatemala; Panama; Venezuela.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Barro Colorado Island (from flowers of *Heliconia mariae*, reported as *dasyophrus* by Barbosa, 1947); Fort Davis, Fort Sherman, Mojinga Swamp.

DARIÉN PROVINCE: El Real.

LOS SANTOS PROVINCE: Las Tablas.

PANAMÁ PROVINCE: Cerro Campana.

DISCUSSION: Through the courtesy of Dr. Irving Fox, of the University of Puerto Rico, we have examined the holotype of *castillae* Fox and find that it is the same species described in 1952 by Wirth as *gibsoni* and by Ortiz as *flochabonnenci*. It is evident upon close examination of the type slide that the fourth pale spot in cell R_5 figured by Fox, the spot lying proximad next to vein M_1 , is actually a small hole torn in the wing. The single hind femur on the type slide is dark at the apex. A close comparison of our material of *castillae* and the excellent descriptions and figures of *flochabonnenci* given by Ortiz convinces us that one species is involved. This species was very numerous in the light trap collections from Lancetilla, Honduras, and at Almirante, Panama, but occurs much more sparingly in the vicinity of the Canal Zone. A remarkable feature of the female of this species is the presence of sensoria on segment XI in addition to those which are more commonly present in other species on III and VIII-X.

65. *Culicoides leopoldoi* Ortiz

FIGURE 68

Culicoides leopoldoi Ortiz, 1952, Rev. Sanid. Asist. Soc., vol. 16, p. 579 (female; Ocumare del Tuy, Venezuela; fig. palpus, antenna, wing, mesonotal pattern); 1952, Acta Cient. Venezolana, vol. 3, p. 127 (female; Panama record; fig. spermatheca, wing, palpus, antenna).—Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 16, p. 596 (male; fig. palpus, wing, genitalia).

FEMALE: Length of wing 0.85 (0.74–0.96, $n=11$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 17:11:12:12:13:13:13:13:21:22:23:23:37, antennal ratio 1.21 (1.12–1.26, $n=7$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 8:14:16:8:8, third segment very short and swollen, 1.8 (1.6–1.9, $n=10$) times as long as greatest breadth, with a large, shallow, irregular sensory pit. Mandible with 12 (12–13, $n=12$) teeth.

Thorax.—Mesonotum yellowish gray pruinose, with a prominent pattern consisting of an H-shaped dark-brown patch, as well as a few small brown punctiform dots between and on each side of the anterior arms of the H. Scutellum dark brown narrowly in middle,

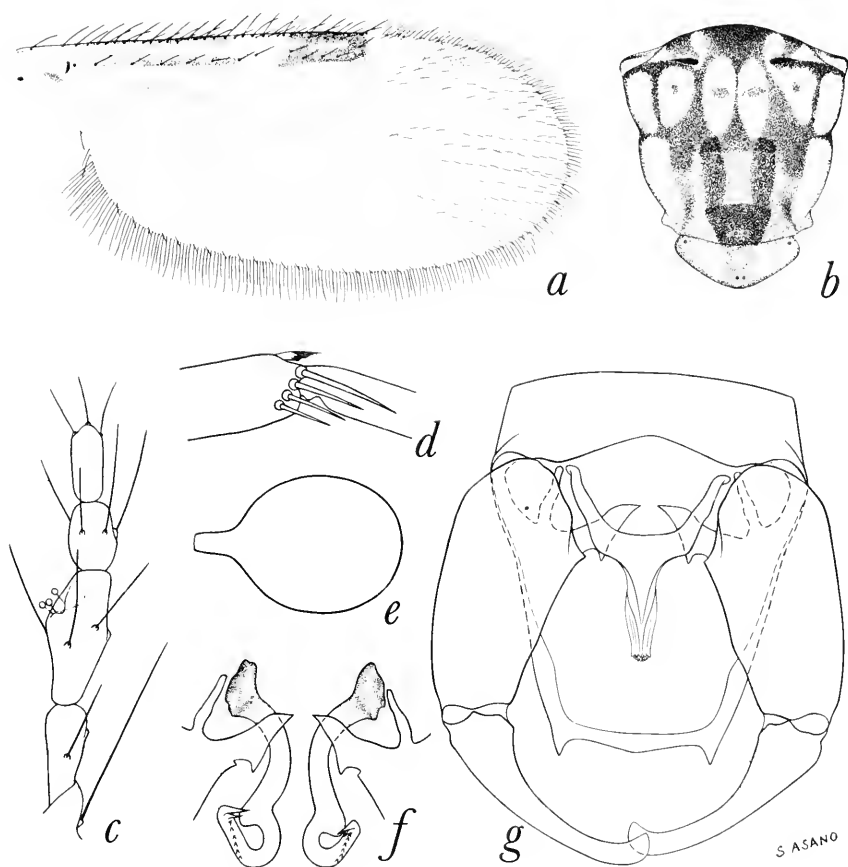


FIGURE 68.—*Culicoides leopoldoi* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermatheca. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

yellowish gray on the sides; postscutellum and pleuron dark brown. Legs dark brown; all femora with subapical, all tibiae with subbasal, and hind tibiae with apical, narrow pale rings; hind tibial comb with four ($n=11$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell very dark, pale spot over r-m crossvein extensive, broadly meeting anterior wing margin; cell R_5 with four pale spots, the anterior poststigmatic spot moderate in size and separated from the two, small, longitudinally aligned, poststigmatic spots, distal pale spot in cell R_5 large, meeting wing margin broadly and bearing a narrow proximal extension; veins M_1 , M_2 and M_{3+4} each with pale spot at wing margin; cell M_1 with two pale spots, the second located far from wing margin; two pale spots in distal part of cell M_2 ; pale spot in cell M_4 small and round and not meeting wing margin; anal cell with two round pale spots in distal part, a large,

irregular pale area at base; cell M_2 with a pale spot lying behind medial fork and one lying in front of mediocubital fork. Macrotrichia scanty on distal third of wing; costa extending to 0.61 (0.59–0.64, $n=11$) of distance to wing tip. Halter knob dark.

Abdomen.—Dark brown, cerci pale. Spermatheca one, pyriform, measuring 0.070 by 0.046 mm., the base of the duct sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum short and tapering with short apicolateral processes. Basistyle with ventral root foot-shaped, dorsal root slender; dististyle slender and moderately curved, with bent tip. Aedeagus with broad, rounded, basal arch extending to less than half of total length, basal arms curved and slender, distal portion slender and simple. Parameres each with large basal knob, stem bent near base, moderately stout, with a well developed ventral lobe, distal portion very slender with a lateral fringe of fine spines.

DISTRIBUTION: Venezuela; Honduras (Lancetilla); Mexico (Tapachula, Chiapas); Panama; Trinidad (Grandwood, Port Delgada, Port of Spain, Tucker Valley).

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Camp Butler, Fort Clayton, Fort Davis, Fort Gulick, Fort Kobbe, Fort San Lorenzo, Galeta Point, Loma Boracho, Madden Dam, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Algarrobo, Chiriquí, Concepción, David, Tortugas.

COCLÉ PROVINCE: Aguadulce, Chirú, Coelé, El Valle, Natá, Puerto Farallón, Puerto Obaldía, Puerto Posado.

COLÓN PROVINCE: Cativá, Pilon, Piña.

DARIÉN PROVINCE: El Real, Garachiné, Punta Patiño.

LOS SANTOS PROVINCE: Pan de Azucar, Puerto Mensabé, Las Tablas.

PANAMÁ PROVINCE: Alcalde Díaz, Arraiján, Capitana, Chepo, Juan Díaz, La Jolla, Naranjal Pacora, Pedregal, Tapagra, Tocumen, Venado Beach, Vique Cove.

ARCHIPIÉLAGO DE LAS PERLAS: Isla del Rey.

VERAGUAS PROVINCE: Divisa, Rio Santa Maria, Sapotilla.

DISCUSSION: This species is related to *castillae* Fox, which also is unusual in this group in having only one spermatheca.

The *transferrans* group

This group consists of medium-sized brownish species with small, round, pale wing spots; two pale spots in apex of anal cell; five distal antennal segments much elongated, (antennal ratio, 1.43–1.85); distal sensory tufts present on segments III, X or XI to XIV; four or five tibial spines, only one spermatheca present; male genitalia of *patulipalpis* similar to those of *debilipalpis*, with foot-shaped ventral root, aedeagus

with pointed basal arch and simple pointed apex; paramere with simple basal knob, prominent ventral lobe and fringed tip.

PANAMA SPECIES: Three: *patulipalpis*, new species; *rangeli* Ortiz and Mirsa; and *transferrans* Ortiz.

66. *Culicoides patulipalpis*, new species

FIGURE 69

FEMALE: Length of wing 0.98 (0.90–1.01, $n=6$) mm.

Head.—Eyes contiguous, with long interfacetal hairs. Antenna with flagellar segments in proportion of 15:9:9:9:10:10:10:11:28:31:32:38:43, antennal ratio 1.85 (1.6–2.1, $n=5$); distal sensory tufts present on segments III, x–xiv. Palpal segments in proportion of 7:18:21:8:8; third segment swollen in middle, 2.0 (1.9–2.3, $n=5$) times as long as greatest breadth, without definite pit, the sensoria borne on mesal, ventral and lateral sides of concaved distal portion. Mandible with 14 (14–15, $n=5$) teeth.

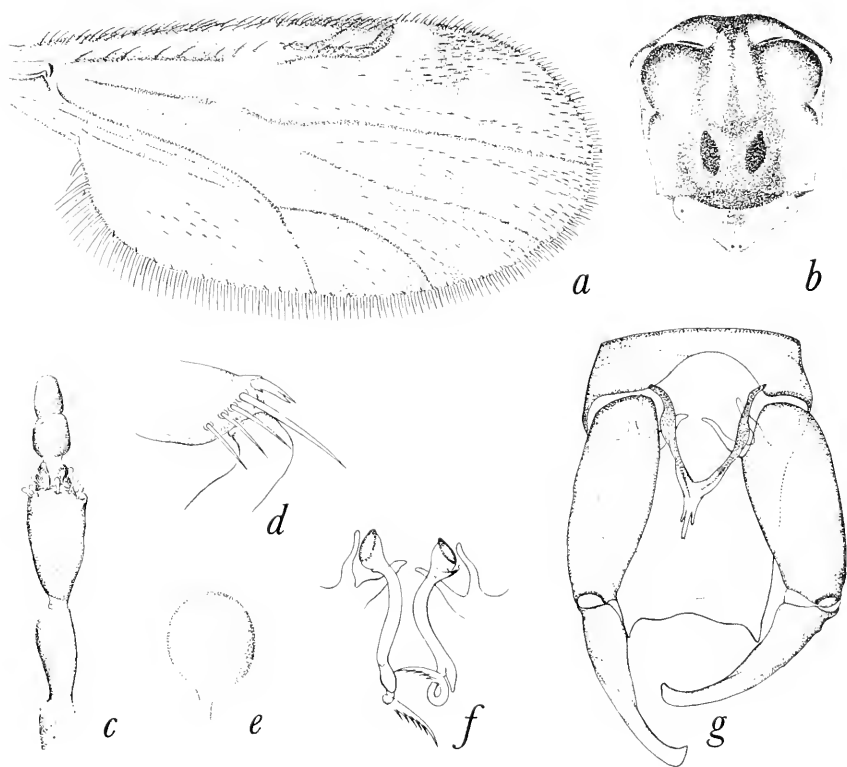


FIGURE 69.—*Culicoides patulipalpis*, new species. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermatheca. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum pruinose brown, with large dark brown patches as figured. Scutellum dark brown broadly in middle, sides narrowly yellowish. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=5$) spines, the one next to the spur longest, very long, a third as long as basitarsus.

Wing.—Pattern as figured; poststigmatic pale spots broadly connected, the posterior one slightly larger and slightly proximad of the anterior one; pale spot in apex of cell R_5 large and transverse, not meeting wing margin; two pale spots in cell M_1 , only one spot in apex of cell M_2 , anal cell with single distal pale spot which broadly reaches wing margin, pale spots present lying behind medial fork and in front of mediocubital fork. Macrotrichia long but only moderately dense on distal half of wing, a few in anal cell; costa extending to 0.64 (0.61–0.67, $n=6$) of distance to wing tip. Halter yellowish.

Abdomen.—Dark brown, cerci yellowish. Spermatheca one, pyriform, measuring 0.051 by 0.041 mm.

MALE GENITALIA: Ninth sternum with a deep caudomedian excavation; ninth tergum long and broad at apex, with short, blunt, triangular apicolateral processes. Basistyle with ventral and dorsal roots long and slender, subequal, no heel-like expansion on ventral root; dististyle long, slender and gently curving. Aedeagus with long, slender, slightly curved basal arms, the apex of the mesal arch narrow, distal portion tapering to a very slender apical point. Parameres each with heavy basal knob, stem slender and curved, bearing a well-developed ventral lobe, the slender, recurved distal portion with a lateral fringe of barbs and tapering gradually to a sharp point.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63170), allotype male, Cerro Campana, Panamá Province, Sept. 19, 1951, F. S. Blanton, light trap. Paratypes, 6 males, 60 females: 3 males, 1 female, Cerro Campana, Aug. 3, 1951, and 2 males, 17 females, Sept. 19, 1951; 36 females, Almirante, Bocas del Toro Province, October, November 1952, January, March 1953; 1 male, 4 females, Mojinga Swamp, Canal Zone, Oct. 24, Dec. 10, 1951; 2 females, Garachiné, Darién Province, February 1953.

DISCUSSION: The elongated five distal antennal segments, some bearing sensoria, the hairy eyes, and the single spermatheca ally *patulipalpis* with *transferrans* Ortiz and *rangeli* Ortiz and Mirsa. The last two species have hairier wings with two distinct pale spots in the distal part of the anal cell; moreover, *transferrans* differs in having a very contrasting mesonotal pattern, palpus with definite pit, sensoria lacking on antennal segment x and the pale spots in cell R_5 often separated into four separate spots, while *rangeli* has a palpus

with an irregular pit, sensoria as in *patulipalpis* and the spots in cell R_5 more restricted, the distal one transverse and the posterior post-stigmatic spot greatly reduced or often entirely absent.

The male genitalia of *patulipalpis* are similar to those of *debilipalpis* Lutz, but in *patulipalpis* the apicolateral processes of the ninth tergite are stouter, the caudomedian excavation of the ninth sternum is much deeper, the apex of the aedeagus is much more pointed, and the ventroposterior lobe on the parameres is longer.

67. *Culicoides rangeli* Ortiz and Mirsa

FIGURE 70

Culicoides rangeli Ortiz and Mirsa, 1952, Acta Cient. Venezolana, vol. 3, p. 126 (female; Los Chorros, Miranda, Venezuela; fig. palpus, antenna; spermatheca; wing).

FEMALE: Length of wing 1.01 (0.91–1.19, $n=9$) mm.

Head.—Eyes nearly contiguous, with long interfacetal hairs. Antenna with flagellar segments in proportion of 17:11:11:12:12:12:12:29:30:31:34:36, antennal ratio 1.63 (1.39–1.79, $n=4$); distal sensory tufts present on segments III, x–xiv. Palpal segments in proportion of 7:17:20:7:8, third segment swollen, 1.9 (1.5–2.1, $n=7$) times as long as greatest breadth, with a very broad, shallow, sensory pit, open and without regular pore. Mandible with 16 (14–20, $n=7$) teeth.

Thorax.—Mesonotum blackish, densely hairy, without apparent pattern. Scutellum uniformly blackish. Legs dark brown; fore and mid femora with subapical and all tibiae with subbasal narrow pale

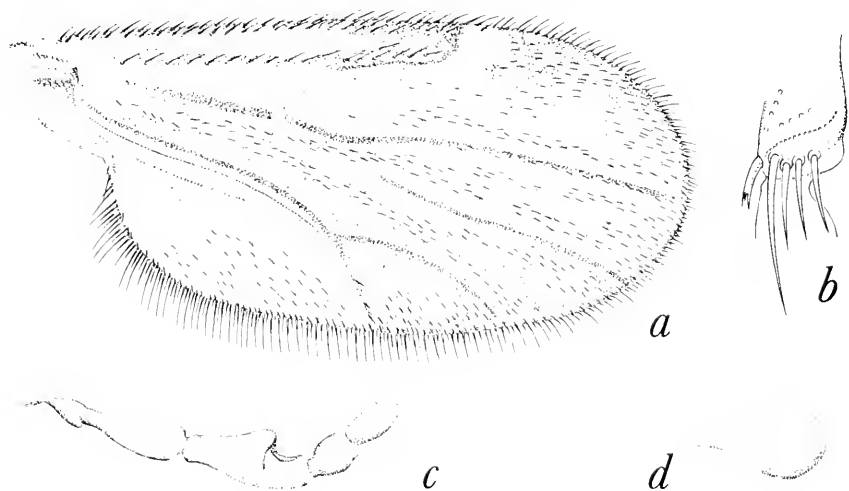


FIGURE 70.—*Culicoides rangeli* Ortiz and Mirsa, female: a, wing; b, tibial comb; c, palpus; d, spermatheca.

rings; hind tibial comb with four ($n=9$) spines, the one next to the spur longest, a third as long as basitarsus.

Wing.—Pattern as figured, posterior poststigmatic pale spot in cell R_5 very small or entirely absent, distal spot in cell R_5 transverse and not double, not attaining wing margin; two very small pale spots each in cell M_1 and in apices of cell M_2 and anal cell; a pale spot present behind medial fork and another in front of mediocubital fork. Macrotrichia very long and dense, numerous in anal cell and in three or four rows to base of cell M ; costa extending to 0.65 of distance to wing tip. Halter pale.

Abdomen.—Dark brown; cerci yellowish. Spermatheca one, pyriform, measuring 0.063 by 0.037 mm., with long sclerotized neck.

MALE: Unknown.

DISTRIBUTION: Venezuela; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Las Cruces.

CHIRIQUÍ PROVINCE: Boquete, Volcán.

DISCUSSION: Characters for the separation of *rangeli* from the closely related *transferrans* Ortiz and *patulipalpis* Wirth and Blanton are discussed under *patulipalpis*. According to the original description and figures given by Vargas (1954), *donajii* Vargas from Chiapas, Mexico, is very close to *rangeli*, differing in the female by the fusion and extension of the two poststigmatic pale spots in cell R_5 .

68. *Culicoides transferrans* Ortiz

FIGURE 71

Culicoides transferrans Ortiz, 1953, Rev. Sanid. Asist. Soc., vol. 18, p. 801 (new species name for *eublepharus* Macfie of Ortiz 1952, misident.; fig. wing, antenna, palpus, spermatheca).

Culicoides eublepharus Ortiz (misident., not Macfie), 1952, Acta Cient. Venezolana, vol. 3, p. 129 (male, female; Venezuela; fig. wing, palpus, spermatheca, male genitalia).

FEMALE: Length of wing 0.98 (0.96–0.99, $n=6$) mm.

Head.—Eyes narrowly separated, with long interfacetal hairs. Antenna with flagellar segments in proportion of 17:12:13:14:14:14:15:25:26:29:32:36, antennal ratio 1.43 (1.24–1.74, $n=3$); distal sensory tufts present on segments III, XI–XIV. Palpal segments in proportion of 8:18:23:8:8, third segment moderately swollen, 2.1 (1.9–2.3, $n=6$) times as long as greatest breadth, with a broad, shallow, sensory pit. Mandible with 15 (14–15, $n=3$) teeth.

Thorax.—Mesonotum with prominent pattern as figured, chocolate brown on the disc with an elongate submedian anterior pair of large yellowish spots, two pairs of lateral spots and extensive prescutellar

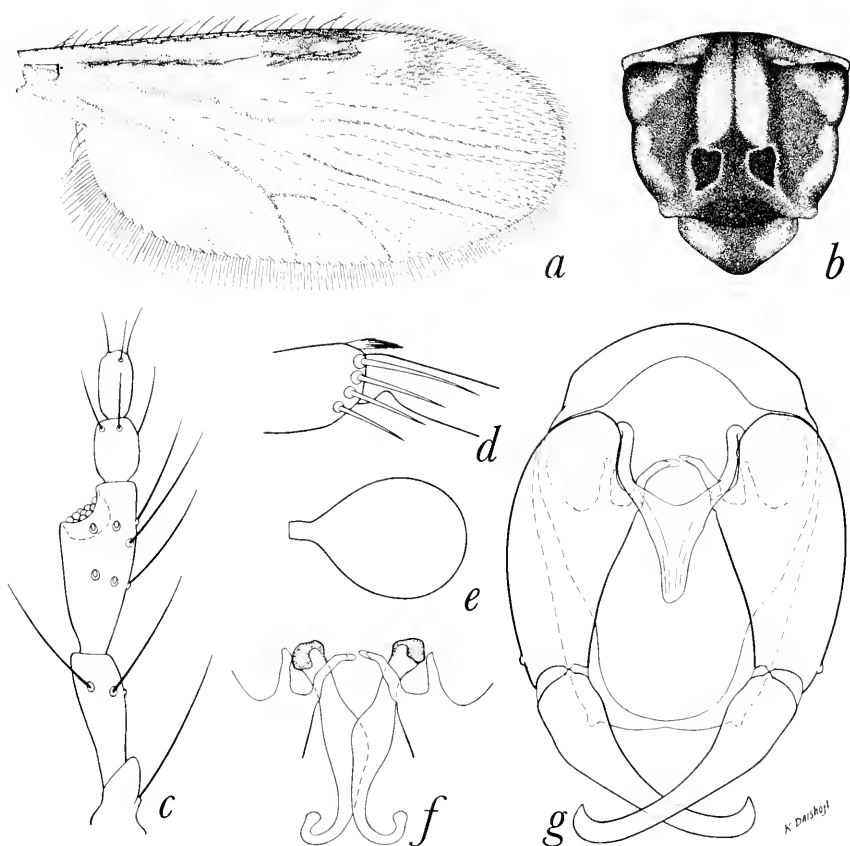


FIGURE 71.—*Culicoides transferrans* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermatheca. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

area pruinose gray-brown. Scutellum yellowish on sides, narrowly dark brown in middle; postscutellum and pleuron dark brown. Legs dark brown, fore and mid femora with subapical and all tibiae with subbasal narrow pale rings; hind tibial comb with four ($n=5$) spines, the one next to the spur longest.

Wing.—Pattern as figured, four pale spots in a rhomboid in cell R_5 , the distal pair usually fused and broadly attaining wing margin anteriorly; two pale spots each in cells M_1 and apices of cells M_2 and anal cell; pale spots present behind medial fork and in front of medio-cubital fork. Macrotrichia moderately dense on distal half of wing, a few extending in a line to basal fourth of cell M and a few in anal cell; costa extending to 0.64 of distance to wing tip. Halter yellowish.

Abdomen.—Dark brown, cerci yellowish. Spermatheca one, oval with a short portion of the duct sclerotized, measuring 0.055 by 0.038 mm.

MALE GENITALIA: Ninth sternum with shallow caudomedian excavation; ninth tergum short with small apicolateral processes. Basistyle with foot-shaped ventral root; dististyle with distal portion curved. Aedeagus with basal arch broadly rounded medially, extending to a half of total length of aedeagus, distal stem slender with rounded apex. Parameres each with knobbed base, stem slightly swollen and bent midway, without ventral lobe, the apex apparently blunt-pointed without lateral barbs.

DISTRIBUTION: Venezuela; Ecuador; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CHIRIQUÍ PROVINCE: Boquete, Volcán.

DISCUSSION: This species is closely related to *rangeli* Ortiz and Mirsa and more distantly to *patulipalpis*, new species (see discussion under *patulipalpis*). The presence of four distinct pale spots in a rhomboid in some specimens might cause confusion with *propriipennis*, which has a third pale spot in cell M_1 at the wing margin, or with *tetrathyris*, new species, which has the apices of veins M_1 , M_2 , and M_{3+4} pale. Both latter species have two spermathecae.

The *leoni* group

This group consists of very small species with nearly bare wings bearing extensive pale markings, wing broad at apex, the poststigmatic pale spots nearly in line transversely and usually broadly fused, the distal pale spot in cell R_5 round and nearly filling apex of cell; one pale spot each in distal parts of cell M_2 and anal cell; antenna of female with flagellar segments in two series, one from III–x, the other from XI–xv, in each of which the segments gradually increase in length distally, segment XI thus shorter than x; distal sensory tufts present on segments III, VII or VIII to x; four tibial spines, only one spermatheca present; male genitalia with ventral root of basistyle foot-shaped; paramere with simple basal knob, stem short, with or without ventral lobe, tip simple or with very few fringing spines; ninth tergum short and broad; aedeagus with or without subapical points.

PANAMA SPECIES: Two: *fieldi* Wirth and Blanton and *glabellus* Wirth and Blanton. Wirth and Blanton (1956) have recently treated the species in this group which, in addition to the above species, includes *benarrochei* Ortiz from Venezuela, *leoni* Barbosa from Ecuador, and *reevesi* Wirth from California.

69. *Culicoides fieldi* Wirth and Blanton

FIGURE 72

Culicoides fieldi Wirth and Blanton, 1956, Bull. Brooklyn Ent. Soc., vol. 51, p. 50 (male, female; Honduras, Panama; fig. wing, palpus, spermatheca, tibial comb, male genitalia).

FEMALE: Length of wing 0.72 (0.66–0.76, $n=9$) mm.

Head.—Eyes contiguous, with long interfacetal hairs. Antenna with flagellar segments in proportion of 14:11:13:14:13:13:14:17:15:15:18:18:29, antennal ratio 0.85 (0.80–0.92, $n=6$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 7:15:15:7:7, third segment moderately swollen, 1.8 (1.7–1.9, $n=8$) times as long as greatest breadth, with a small, deep, sensory pit. Mandible with 12 (11–13, $n=11$) teeth.

Thorax.—Mesonotum (only slide mounted specimens available) apparently without prominent pattern, dark brown. Scutellum, postscutellum and pleuron dark brown. Legs brown, fore and mid femora with very faint subapical pale rings, all tibiae with subbasal and hind tibia with apical distinct pale rings; hind tibial comb with four ($n=10$) spines, the longest one nearest the spur.

Wing.—Pattern as figured; pale spot over r-m crossvein small; poststigmatic pale spots in cell R_5 more or less separated into two

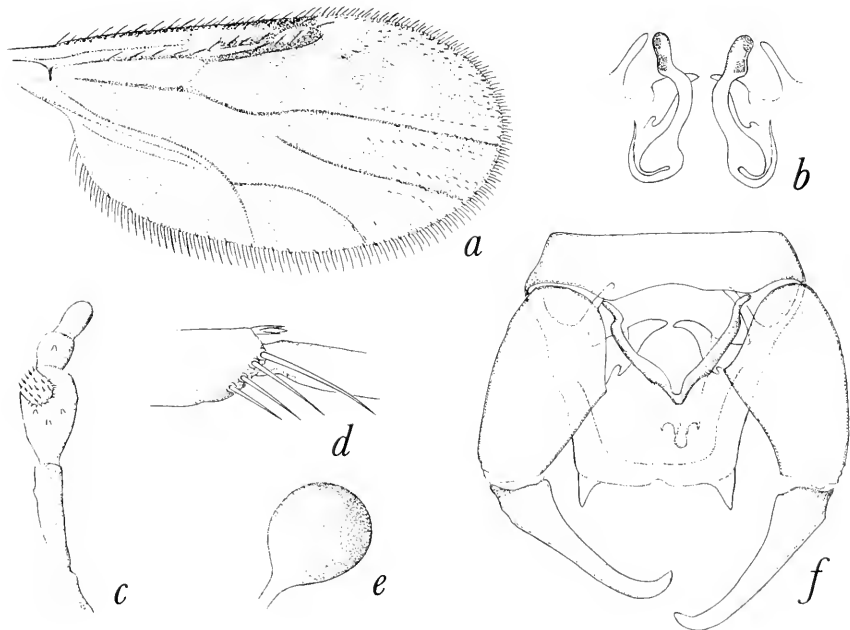


FIGURE 72.—*Culicoides fieldi* Wirth and Blanton. a, c–e, Female: a, wing; c, palpus; d, tibial comb; e, spermatheca. b, f, Male: b, parameres; f, genitalia, parameres removed.

distinct, small round spots, the posterior one located distinctly proximad of the anterior one; distal pale spot in cell R_5 small and round, located in center of cell; two pale spots in cell M_1 ; only one pale spot each in apices of cells M_2 , M_4 and anal cell; pale spot present behind medial fork but no pale spot in front of mediocubital fork. Macrotrichia very sparse on distal fourth of wing, none located proximad of level of end of costa; costa extending to 0.60 (0.59–0.62, $n=9$) of distance to wing tip. Halter infuscated.

Abdomen.—Blackish, cerci yellowish. Spermatheca one, pyriform, measuring 0.057 by 0.038 mm., the base of the duct sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum very narrow, caudomedian excavation not developed, the posterior membrane not spiculate; ninth tergum short with truncate apex, apicolateral processes long and slender. Basistyle with ventral lobe large and foot-shaped, the posterior heel pointed, dorsal root slender; dististyle long and slender with hooked apex. Aedeagus with basal arch extending to more than half of total length, mesal apex of arch narrow, the basal arms nearly straight and well sclerotized; distal portion tapering to a slender rounded tip, with a subapical, lateral pair of sclerotized points arising near juncture with the arch. Parameres each with small basal knob, stem slender, abruptly bent near base, the straight portion comparatively short with a long ventral lobe distad, beyond which the paramere is very slender, tapering rapidly to a simple fine-pointed tip.

DISTRIBUTION: Honduras; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Fort Clayton, Loma Boracho, Mindi Dairy.

CHIRIQUÍ PROVINCE: Volcán.

DISCUSSION: *Culicoides dasyophrus* Macfie has a wing pattern almost identical with that of *fieldi*, but the antennae of *dasyophrus* are much different, with an antennal ratio of at least 1.5. The antennae of *fieldi* are much like those of the closely related *benarrochei* Ortiz; *glabellus*, new species; *leoni* Barbosa; and *reevesi* Wirth, but the presence of two separate, poststigmatic pale spots in cell R_5 with the posterior one located distinctly proximad of the anterior one is characteristic only of *fieldi* and *benarrochei*. *C. benarrochei* can be separated from *fieldi* by its shorter second palpal segment (ninth-thirteenths as long as third segment), antennal segments XI, XII, XIII, and XIV subequal in length and by the presence of a distinct pale spot in front of the mediocubital fork. The long ventral lobe on the male paramere is diagnostic of *fieldi*.

70. *Culicoides glabellus* Wirth and Blanton

FIGURE 73

Culicoides glabellus Wirth and Blanton, 1956, Bull. Brooklyn Ent. Soc., vol. 51, p. 47 (male, female; Panama, Honduras, Nicaragua, Trinidad; fig. wing, mesonotum, palpus, tibial comb, spermatheca, male genitalia).

FEMALE: Length of wing 0.68 (0.66–0.76, $n=11$) mm.

Head.—Eyes narrowly separated, with short interfacetal hairs. Antenna with flagellar segments in proportion of 15:11:12:13:13:13:14:17:15:15:18:18:29, antennal ratio 0.91 (0.88–0.95, $n=8$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 6:16:15:7:8; third palpal segment slightly swollen, 1.8 (1.7–2.1, $n=11$) times as long as greatest breadth, with small, deep sensory pit. Mandible with 12 (11–13, $n=13$) teeth.

Thorax.—Mesonotum very dark brown, with faint pattern as figured, consisting of a sublateral pair of blackish bands. Scutellum uniformly dark brown; postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical, all tibiae with sub-

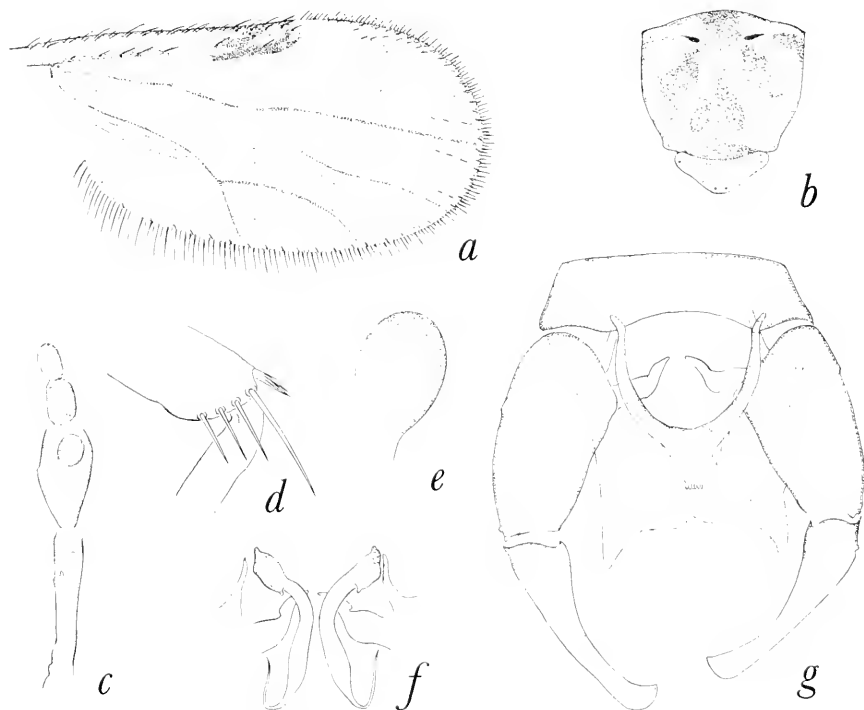


FIGURE 73.—*Culicoides glabellus* Wirth and Blanton. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermatheca. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

basal and hind tibia with apical, narrow whitish rings; hind tibial comb with four ($n=10$) spines, the longest one next to the spur.

Wing.—Pattern as figured; poststigmatic pale spot in cell R_5 only rarely incompletely divided into two separate spots, these located at same distance from base of wing, the spot never extending caudad as far as vein M_1 ; pale spot in apex of cell R_5 large and rounded, usually filling most of the space between anterior wing margin and vein M_1 ; two pale spots in cell M_1 , only one pale spot each in apices of cell M_2 and anal cell, pale spots present lying in front of mediocubital fork and behind medial fork. Macrotrichia very sparse in extreme apices of cells R_5 , M_1 and M_2 ; costa extending to 0.65 of wing length, wing broader than usual on distal half. Halter whitish.

Abdomen.—Dark brown, cerci yellowish. Spermatheca one, pyriform, measuring 0.059 by 0.038 mm., with long sclerotized duct.

MALE GENITALIA: Ninth sternum with very shallow, broad, caudo-median excavation; the posterior membrane bare; ninth tergum short, the apex distinctly notched in middle with prominent, triangular, apicolateral processes. Basistyle with short ventral and dorsal roots, the posterior heel not developed on ventral root; dististyle slender, only slightly curved. Aedeagus with broad, distally rounded, basal arch, the basal arms distinctly curved; distal stem broad at base with a pair of hyaline, sublateral, rounded lobes, the median point slender and rounded at tip. Parameres each with large basal knob, stem slender and gradually curved on basal portion, more swollen toward apex of straight portion, ventral lobe absent, apex abruptly tapered to simple filiform tip directed ventrad.

DISTRIBUTION: Panama; Honduras; Nicaragua; Trinidad.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante (type locality).

CANAL ZONE: Camp Butler, Mojinga Swamp.

DISCUSSION: In general appearance, size, and wing markings *glabellus* is practically identical with *leoni* Barbosa and *gabaldoni* Ortiz. There are two spermathecae, however, in *gabaldoni*, and *leoni* differs in having an antennal ratio of only 0.75 and sensoria present on segment VII as well as on III, VIII–X. All three species have the remarkable repetition of increasing lengths of segments in the antennal series with segment XI always shorter than X. The male genitalia of *glabellus* can be readily distinguished by the gradually curving base of the paramere, the stem swollen at the distal part of the straight portion, beyond which the paramere tapers rapidly to a simple, filamentous tip.

The *debilipalpis* group

This group consists of small species with dark brown mesonotum, rarely with prominent pattern; wing with small round spots, one or two in distal part of cells R_5 and M_1 , and only one spot in distal parts of cell M_2 and anal cell, all far from wing margin; apices of veins dark; antenna with flagellar segments in one series of gradually increasing lengths, no break between segments x and xi, sensoria present on segments iii, and vii or viii to x; four tibial spines; two spermathecae; male genitalia with ventral root of basistyle foot-shaped, paramere with simple basal knob and fringed apex; aedeagus with subapical or apical sclerotized points, these often remarkably developed.

PANAMA SPECIES: Ten: *aureus* Ortiz, *debilipalpis* Lutz, *gabaldoni* Ortiz, *ginesi* Ortiz, *glabrior* Macfie, *hoffmani* Fox, *imitator* Ortiz, *mirsaе* Ortiz, *paraensis* (Goeldi), and *spurius*, new species.

71. *Culicoides gabaldoni* Ortiz

FIGURE 74

Culicoides gabaldoni Ortiz, 1954, Arch. Venezolana Patol. Trop. Parasit. Med., vol. 2, p. 221 (female; Venezuela; fig. wing, antenna, palpus, spermathecae).
Culicoides germanus Wirth (misident., not Macfie), 1955, Proc. Ent. Soc. Washington, vol. 57, p. 111 (male, female; Guatemala; fig. male genitalia).

FEMALE: Length of wing 0.65 (0.55–0.79, $n=14$) mm.

Head.—Eyes broadly separated, with long interfacetal hairs. Antenna with flagellar segments in proportion of 18:9:10:11:11:12:14:13:12:16:17:25, antennal ratio 0.91 (0.85–0.96, $n=9$); distal sensory tufts present on segments iii, viii–x. Palpal segments in proportion of 6:14:16:5:9, third segment moderately swollen, 1.8 (1.7–2.1, $n=13$) times as long as greatest breadth, with a small, very deep sensory pit. Mandible with 11 (10–15, $n=13$) teeth.

Thorax.—Mesonotum very dark brown with bluish gray pruinosity, with pattern of two sublateral, narrow, blackish vittae. Scutellum, postscutellum and pleuron dark brown. Legs pale brown, hind femur darker; fore and mid femur with subapical, all tibiae with subbasal and hind tibia with apical, broad pale bands; hind tibial comb with four ($n=12$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, the two poststigmatic pale spots in cell R_5 fused into a single quadrate pale area extending nearly to vein M_1 , with the posterior portion of the area usually extending slightly distad of the anterior portion, distal pale spot in cell R_5 large and rounded, nearly filling space between anterior wing margin and vein M_1 ; two pale spots in cell M_1 ; one pale spot each in apices of cell M_2 ,

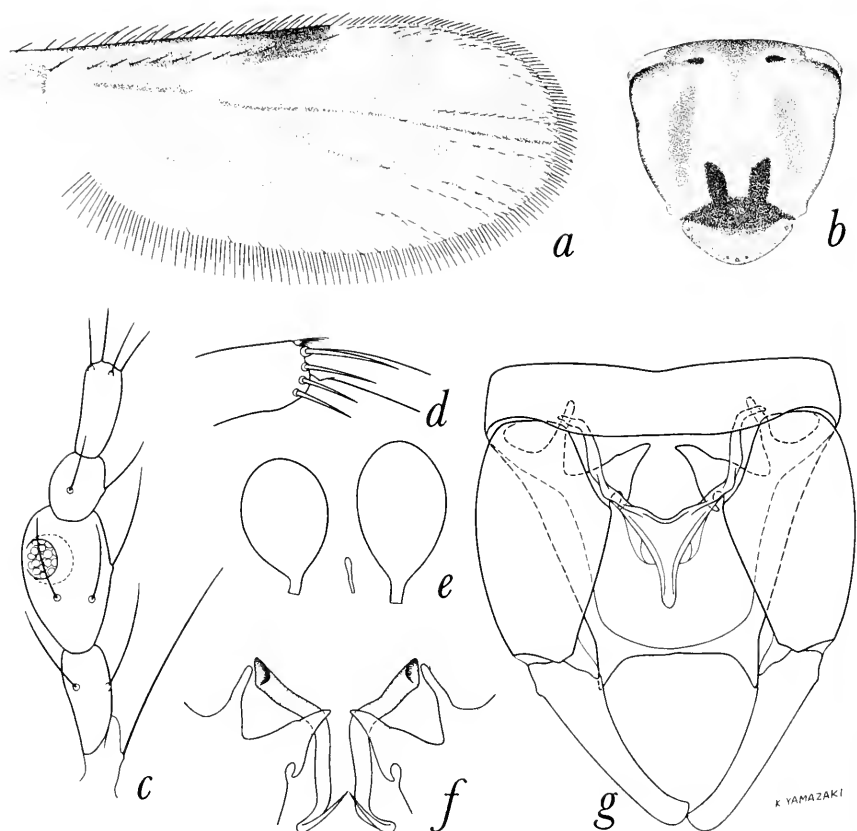


FIGURE 74.—*Culicoides gabaldoni* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

cell M_4 , and anal cell; pale spot in anal cell sometimes extending to wing margin; pale spot present behind medial fork, but no pale spot present in front of mediocubital fork. Macrotrichia practically absent, a few in rows in apices of cells R_5 , M_1 and M_2 ; costa extending to 0.62 (0.59–0.65, $n=14$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, ovoid, slightly unequal, measuring 0.045 by 0.028 mm. and 0.036 by 0.026 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with very slight caudomedian excavation; ninth tergum short and tapering, with long, slender apicolateral processes, the caudal margin between the processes straight. Basistyle with foot-shaped ventral root, dorsal root stout and nearly as long; dististyle short and slender, nearly straight with hooked apex. Aedeagus with basal arch attaining one-half to two-thirds of total length, rounded mesally, the basal arms stout and

curved, distal stem tapered to an apical rounded point with a pair of small, sharp, subapical, lateral, sclerotized projections. Parameres each with small basal knob; stem abruptly bent and slightly swollen near base, slender and tapering distad, without ventral lobe; apex tapering to sharp point without lateral barbs.

DISTRIBUTION: Venezuela; Guatemala; Honduras (Lancetilla, Tela); Nicaragua (Villa Somoza); Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Loma Boracho, Mojinga Swamp.

COCLÉ PROVINCE: Río Hato.

DARIÉN PROVINCE: Punta Patiño.

LOS SANTOS PROVINCE: Puerto Mensabé.

DISCUSSION: In pinned material females of *gabaldoni* are practically inseparable from *leoni* Barbosa and *glabellus* Wirth and Blanton, although in *gabaldoni* the legs are paler and there may be a few more hairs at the apex of the wing, arranged in rows. This resemblance is also borne out in slide-mounted material by the similarity in the series of antennal segments, the 11th and 12th segments being shorter than the 10th, but *leoni* differs from the other two in having an antennal ratio of only 0.75 and in having sensoria on segment VII as well as on III and VIII-X. Females of *leoni* and *glabellus* differ from *gabaldoni* in having only one spermatheca. The male genitalia of *gabaldoni* can be recognized readily by the parameres being abruptly bent and slightly swollen at the base, with simple, filamentous apex. *Culicoides imitator* Ortiz also resembles *gabaldoni* but has macrotrichia on the distal half of the wing, antennal segment XI is not shorter than X and the third palpal segment does not bear a definite sensory pit. *Culicoides horticola* Lutz also has a similar wing pattern but lacks the pale spot lying behind the medial fork as well as the one in front of the mediocubital fork.

72. *Culicoides spurius*, new species

FIGURE 75

FEMALE: Length of wing 0.72 (0.69–0.79, $n=10$) mm.

Head.—Eyes broadly separated, with short interfacetal hairs, the interocular space not markedly narrowed below. Antenna with flagellar segments in proportion of 14:10:12:13:13:13:13:13:14:16:15:27, antennal ratio 0.84; distal sensory tufts present on segments III, VII-X. Palpal segments in proportion of 7:14:17:7:8, third segment very short and swollen, 1.8 (1.6–2.1, $n=10$) times as long as greatest breadth, with a large, deep sensory pit opening by a small pore. Mandible with 13 (12–14, $n=8$) teeth.

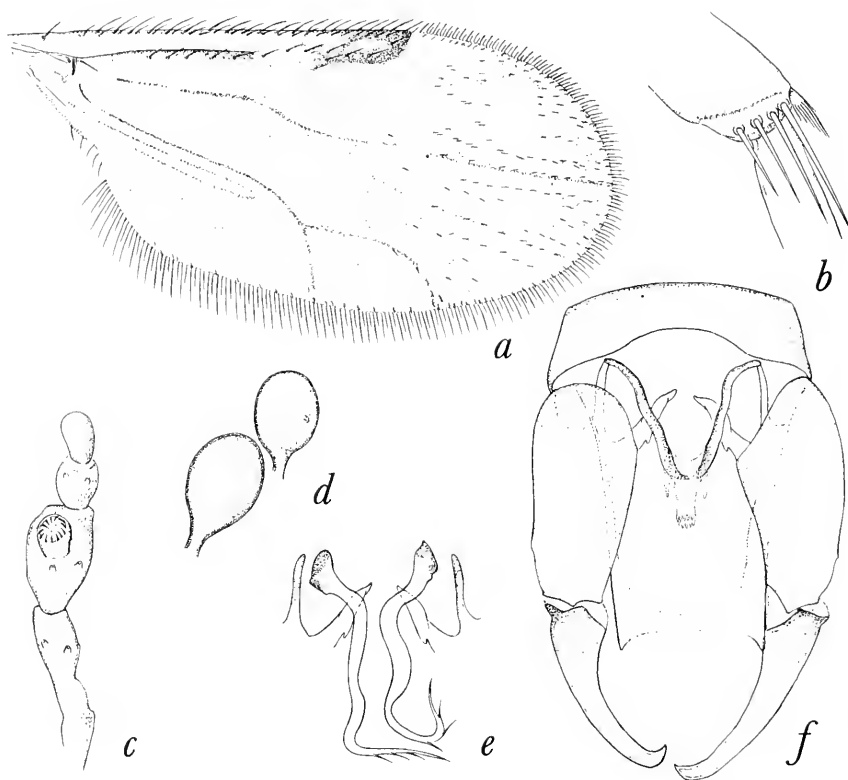


FIGURE 75.—*Culicoides spurius*, new species. *a-d*, Female: *a*, wing; *b*, tibial comb; *c*, palpus; *d*, spermathecae. *e, f*, Male: *e*, parameres; *f*, genitalia, parameres removed.

Thorax.—Mesonotum (only slide-mounted specimens available) apparently without conspicuous pattern, dark brown. Scutellum, postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; pale spots small, moderately distinct; pale spot over r-m crossvein about as broad as long, poststigmatic pale spots in cell R_5 small and rounded, well separated, the posterior one slightly larger and located slightly proximad of the anterior one; distal pale spot in cell R_5 moderately large, rounded; two pale spots in cell M_1 , one pale spot each in apices of cell M_2 , M_4 and anal cell; definite pale spots present behind medial fork and in front of mediocubital fork. Macrotrichia sparse on distal third of wing, none in cell M_4 , anal cell

or base of cell M_2 ; costa extending to 0.58 (0.58–0.60, $n=10$) of distance to wing tip. Halter knob infuscated.

Abdomen.—Brownish black, cerci yellowish. Spermathecae two, slightly unequal, pyriform, measuring 0.048 by 0.033 mm. and 0.042 by 0.026 mm., the bases of the ducts sclerotized a very short distance.

MALE GENITALIA: Ninth sternum with broad, shallow, caudo-median excavation; ninth tergum long, tapering, with short, pointed apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel well developed, dorsal root slender; dististyle long and slender with hooked apex. Aedeagus with basal arch rounded, extending to more than half of total length of aedeagus, basal arms slender and nearly straight; distal portion with a slender, tapering median stem with rounded, distally striated, apical point, flanked by a pair of long, triangular, sharp pointed, poorly sclerotized processes arising from main body of aedeagus near base of distal stem. Parameres each with large basal knob, stem moderately slender, abruptly bent a short distance from base, midportion sinuate and slightly swollen ventrally, distal portion slender, abruptly bent ventrad with pointed apex bearing a few lateral barbs.

DISTRIBUTION: Panama; Guatemala; Honduras:

SPECIMENS EXAMINED: Holotype female (USNM 63171), allotype, Fort Davis, Canal Zone, Oct. 7, 1953, F. S. Blanton, light trap. Paratypes, 23 males, 17 females: PANAMA: Bocas del Toro Province: 4 females, Almirante, Nov. 10, 1952, Jan. 18, 1953. Canal Zone: 12 males, 2 females, same data as type; 1 male, 3 females, Huile Sia Clara (?), Oct. 13, 1952; 5 males, 3 females, Loma Boracho, Nov. 27, 1951, June 14, 1952; 2 females, Mojinga Swamp, Nov. 27, 1951, Nov. 15, 1953. Chiriquí Province: 1 male, Pedregal, Sept. 29, 1952. Darién Province: 1 female, El Real, July 1952. HONDURAS: 3 males, 1 female, Lancetilla, Jan. 5, 1953, Jan. 29, 1953, P. Galindo, light trap; 1 male, Tela, June 10, 1953, P. Galindo, light trap. GUATEMALA: 1 female, Yepocapa, July 26, 1951, Gibson and Ascoli, at light.

DISCUSSION: *C. spurius* is similar to *hoffmani* Fox, but the latter species differs from it in having the antennal ratio about 0.79, the second palpal segment much shorter than the third (12:19), the third segment even stouter, 1.6 times as long as broad, the wing larger, averaging 0.76 mm. long, and an average of 14 mandibular teeth. The male genitalia of *hoffmani* differ markedly—the apicolateral processes on the ninth tergum much larger, the aedeagus with broadly expanded and well-sclerotized apex with three subequal distal processes. *C. imitator* Ortiz is also closely related, but it has no definite pit on the third palpal segment and the male aedeagus is broad and truncated distally without distal processes.

73. *Culicoides hoffmani* Fox

FIGURE 76

Culicoides hoffmani Fox, 1946, Ann. Ent. Soc. Amer., vol. 39, p. 251 (female; Cumuto Village, Trinidad; biting man; fig. mesonotum, wing); 1949, Bull. Brooklyn Ent. Soc., vol. 44, p. 29 (male, female; Puerto Rico; reared, tree hole; fig. palpus, spermathecae, male aedeagus, parameres).—Wirth and Blanton, 1956, Journ. Washington Acad. Sci., vol. 46, p. 189 (male, female; Trinidad, Puerto Rico, St. Croix; fig. wing, mesonotum, palpus, spermathecae, tibial comb, male genitalia).

FEMALE: Length of wing 0.76 (0.73–0.86, $n=9$) mm.

Head.—Eyes separated, the line of separation broad above but narrowed below, eye with short interfacetal hairs. Antenna with

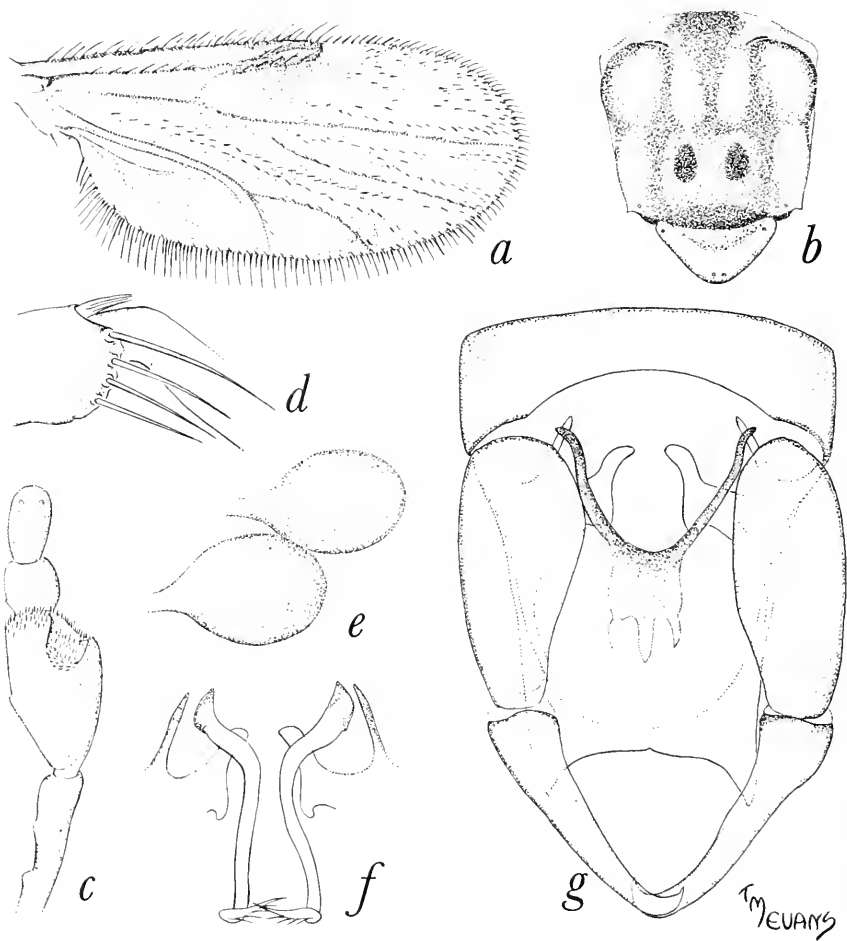


FIGURE 76.—*Culicoides hoffmani* Fox. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

flagellar segments in proportion of 14:11:13:15:15:14:14:15:14:14:15:15:25, antennal ratio 0.79 (0.75–0.84, $n=3$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 6:11:19:6:7, third segment very short and swollen, 1.6 (1.5–1.7, $n=9$) times as long as greatest breadth, with a moderately large and deep sensory pit. Mandible with 14 (13–15, $n=5$) teeth.

Thorax.—Mesonotum pruinose brown with pattern as figured, consisting essentially of a sublateral pair of darker brown patches, widest at midlength; scutellum, postscutellum and pleuron dark brown. Legs dark brown, fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=9$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; two, slightly separated, poststigmatic pale spots in cell R_5 , the posterior one lying only slightly proximad of the anterior one; distal pale spot in cell R_5 moderately large, rounded; two pale spots in cell M_1 ; one pale spot each in apices of cells M_2 , M_4 and anal cell, the one in anal cell failing by its own diameter to meet wing margin; a pale spot lying ahead of medio-cubital fork and another pale spot lying behind medial fork. Macrotrichia sparse on distal third of wing, none in anal cell, cell M_4 or base of cell M_2 ; costa extending to 0.59 (0.57–0.62, $n=9$) of distance to wing tip, second radial cell well developed. Halter brown, the flat end of the knob whitish.

Abdomen.—Blackish, cerci pale. Spermathecae two, pyriform, slightly unequal, measuring 0.048 by 0.034 mm. and 0.043 by 0.031 mm.

MALE GENITALIA: Ninth sternum with very broad and shallow caudomedian excavation; ninth tergum long, with large, triangular, apicolateral processes. Basistyle with ventral root large and foot-shaped, dorsal root slender; dististyle slender and nearly straight with hooked apex. Aedeagus with basal arch rounded caudad, extending slightly more than half of total length of aedeagus, basal arms slender and curved; distal apex broadly expanded and well sclerotized, with three pointed lobes of subequal lengths. Parameres each with knobbed base, stem abruptly bent near base, very slender, midportion sinuate, no trace of ventral lobe, apex pointed with lateral fringe of fine hairs.

DISTRIBUTION: Trinidad; Panama; Puerto Rico; Virgin Islands.

PANAMA RECORDS:

CANAL ZONE: Fort Clayton.

PANAMÁ PROVINCE: Isla Taboga.

DISCUSSION: These new Panama records are based on two males, the genitalia of which show the very distinctive characters of *hoffmani*.

74. *Culicoides imitator* Ortiz

FIGURE 77

Culicoides imitator Ortiz, 1953, Rev. Sanid. Asist. Soc., vol. 18, p. 808 (male, female; Ocumare del Tuy, Venezuela; fig. wing, palpus, antenna, eye, spermathecae).

FEMALE: Length of wing 0.68 (0.64–0.73, $n=5$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 13:8:8:10:10:10:10:10:11:11:14:15:21, antennal ratio 0.91; distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 8:16:16:7:8, third segment slightly swollen, 1.9 (1.7–2.1, $n=4$) times as long as greatest breadth, with a large, irregular, open sensory area on mesal side. Mandible with 13 ($n=5$) teeth.

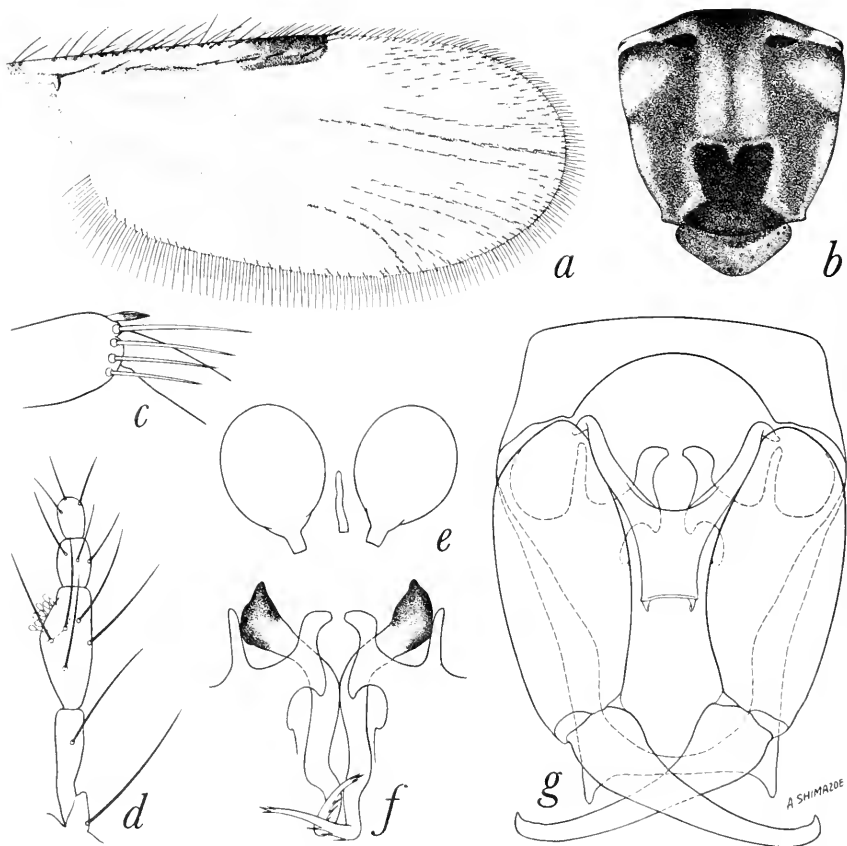


FIGURE 77.—*Culicoides imitator* Ortiz. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, tibial comb; *d*, palpus; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum brownish black with pattern as figured, a pair of large, elongate, submedian anterior spots and irregular area on lateral margins pruinose grayish brown. Scutellum, postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=5$) spines, the two nearest the spur longest, subequal.

Wing.—Pattern as figured, pale spots small and definite; a small yellowish spot over r-m crossvein to costal wing margin; the poststigmatic pale spots in cell R_5 small, more or less fused, the two at the same level or the posterior one slightly distad of the other; distal pale spot in cell R_5 small, rounded and not reaching wing margin; two pale spots in cell M_1 ; one pale spot in apex of cell M_2 , cell M_4 and anal cell; no pale spot lying ahead of mediocubital fork but a distinct pale spot lying behind medial fork. Macrotrichia moderately numerous, situated more or less in rows, on distal portion of wing beyond end of costa, none in anal cell or base of cell M_2 ; costa extending to 0.53 (0.52–0.55, $n=5$) of distance to wing tip. Halter pale.

Abdomen.—Dark brown; cerci pale. Spermathecae two, ovoid, subequal, measuring 0.046 by 0.038 and 0.042 by 0.025 mm., the bases of the ducts lightly sclerotized a short distance.

MALE GENITALIA: Ninth sternum with broad, shallow, caudo-median excavation; ninth tergum moderately long and tapering, with short, pointed, apicolateral processes. Basistyle with ventral root stout, foot-shaped, the posterior heel not prolonged, dorsal root slender; dististyle long and slender, nearly straight with bent, pointed apex. Aedeagus short and stout, basal arch reaching about half of total length, the basal arms stout and heavily sclerotized, distal portion broad and spatulate with truncated apex. Parameres each with large basal knob, stem slender, abruptly bent near base, sinuate in midportion, abruptly bent near apex, ventral lobe only slightly developed, apex pointed with lateral fringe of fine barbs.

DISTRIBUTION: Venezuela; Panama.

PANAMA RECORDS:

CANAL ZONE: Mojinga Swamp.

LOS SANTOS PROVINCE: Puerto Mensabé.

DISCUSSION.—This species is closely related to *hoffmani* Fox, but can be distinguished easily by the open sensory area on the third palpal segment and by the more definite wing markings in which the posterior poststigmatic pale spot is usually slightly distad of the anterior one. The male genitalia of the Panama specimens differ slightly from those of the type figured by Ortiz in having large distal teeth on the aedeagus and the stem of the paramere stouter with small processes. A longer series of males would have to be examined to determine if these differ-

ences are constant enough to warrant specific recognition. The female characters closely fit those of the type from Venezuela.

75. *Culicoides paraensis* (Goeldi)

FIGURE 78

Haematomyidium paraense Goeldi, 1905, Mem. Mus. Goeldi, vol. 4, p. 137 (female; Pará, Brazil; fig. female, wing).

Culicoides paraensis, Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 55 (male, female; Brazil; fig. wing).—Floch and Abonnenc, 1942, Inst. Pasteur Guyane Terr. l'Inini, publ. 37, p. 4 (French Guiana; fig. wing).—Fairchild, 1943, Amer. Journ. Trop. Med., vol. 23, p. 572 (Chiriquí, Panama).—Barretto, 1944, Anais Fac. Med. Univ. São Paulo, vol. 20, p. 92 (male; Brazil; fig. wing, genitalia).—Ortiz, 1951, Rev. Sanid. Asist. Soc., vol. 16, p. 574 (male, female; Venezuela; fig. wing, palpus, antenna, mesonotal pattern, spermathecae, male aedeagus, parameres).—Fox, 1955, Journ. Agr. Univ. Puerto Rico, vol. 39, p. 250 (extensive synonymy).

Culicoides undecimpunctatus Kieffer, 1917, Ann. Mus. Nat. Hungarici, vol. 15, p. 307 (female; Argentina).

FEMALE: Length of wing 0.78 (0.69–0.89, $n=8$) mm.

Head.—Eyes broadly separated, bare. Antenna with flagellar segments in proportion of 15:11:12:14:14:14:14:15:15:16:16:16:25, antennal ratio 0.77 (0.71–0.81, $n=5$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 8:17:20:7:10, third segment slightly swollen, 2.1 (1.7–2.4, $n=9$) times as long as greatest breadth, with a small, deep sensory pit. Mandible with 15 (14–15, $n=6$) teeth.

Thorax.—Mesonotum dark brown with dark grayish pruinosity, three more or less prominent longitudinal vittae present anteriorly, the lateral ones widened at sutural level. Scutellum, postscutellum, and pleuron brownish black. Legs dark brown, fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=9$) spines, the second from the spur longest.

Wing.—Pattern as figured; second radial cell dark; pale spot over r-m crossvein narrow, extending to coastal margin; cell R_3 with four small, round pale spots, the two poststigmatic spots well separated and located one behind the other, the posterior one located slightly proximad, apices of veins dark at wing margin; three small pale spots in cell M_1 ; only one pale spot in distal part of cell M_2 ; a round pale spot in center of cell M_4 ; anal cell with one pale spot in distal portion; cell M_2 with a pale spot lying behind medial fork, none in front of mediocubital fork; a pale spot lying just distad of basal arculus. Macrotrichia sparse and in rows on distal half of wing, a few in base of cell M_2 and in anal cell; costa extending to 0.59

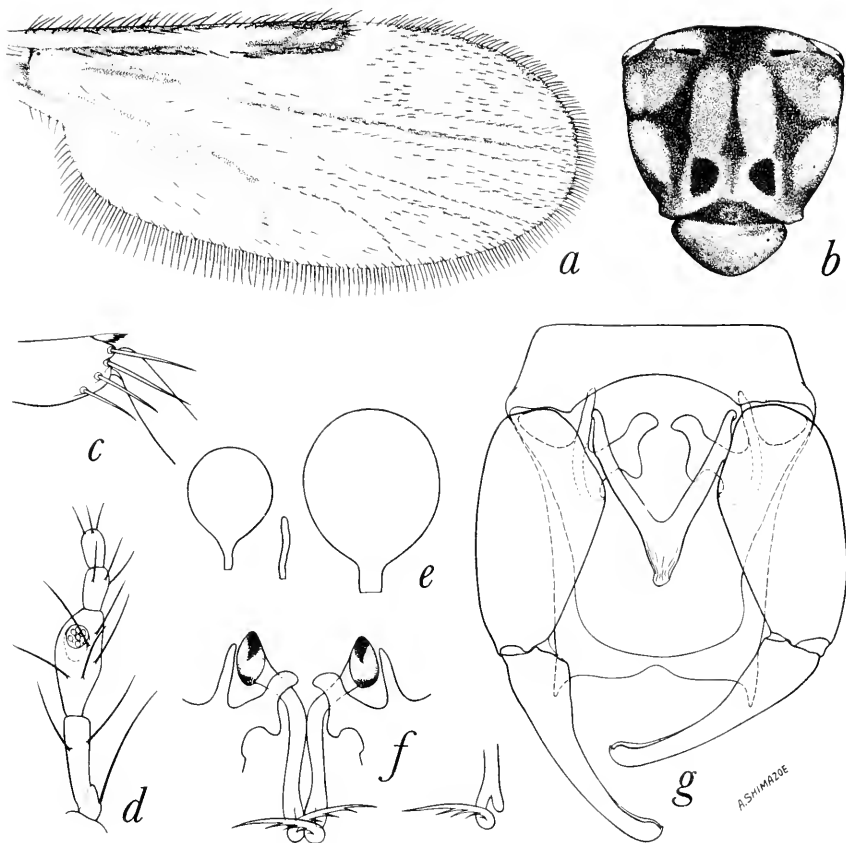


FIGURE 78.—*Culicoides paraensis* (Goeldi). *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, tibial comb; *d*, palpus; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

(0.56–0.60, $n=8$) of distance to wing tip. Halter pale, base of knob brownish.

Abdomen.—Dark brown, cerci yellowish. Spermathecae two, pyriform, unequal, measuring 0.057 by 0.037 mm. and 0.048 by 0.029 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with a broad, shallow, caudo-median excavation; ninth tergum long and tapering with short, pointed, widely separated apicolateral processes. Basistyle with ventral root foot-shaped, and posterior heel well developed, dorsal root short; dististyle slender and curved with bent tip. Aedeagus V-shaped, the basal arch pointed and extending to two-thirds of total length, the basal arms straight and moderately stout, the distal portion with simple, rounded tip. Parameres each with large basal

knob, stem slender, bent at some distance from base, midportion straight with a well-developed ventral lobe, distal portion abruptly bent and tapered to fine point with a lateral fringe of fine spines.

DISTRIBUTION: Widely distributed in South and Central America and the West Indies, from Argentina and Bolivia to Mexico and the eastern United States.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Camp Piña, Fort Clayton, Fort Davis, Fort San Lorenzo, France Field, Huile Sia Clara (?), Loma Boracho, Madden Dam, Mindi Dairy, Mojinga swamp.

COCLÉ PROVINCE: El Valle, La Venta, Puerto Farallón, Río Hato.

COLÓN PROVINCE: Piña.

DARIÉN PROVINCE: Garachiné, Jaqué, Punta Patiño.

LOS SANTOS PROVINCE: Puerto Mensabé.

PANAMÁ PROVINCE: Arraiján, Camarón, Cerro Campana, El Coco, La Jolla, Pacora, Pedregal, Tocumen.

DISCUSSION: Structurally *paraensis* is a typical member of the *debilipalpis* group with male genitalia nearly identical with those of *debilipalpis* Lutz. It can be readily separated from all other members of this group, however, by the presence of small round pale spots at the extreme apices of cells R_5 and M_1 .

76. *Culicoides debilipalpis* Lutz

FIGURE 79

Culicoides debilipalpis Lutz, 1913, Mem. Inst. Oswaldo Cruz, vol. 5, p. 60 (female; Brazil; fig. wing).—Costa Lima, 1937, idem., vol. 32, p. 415 (fig. palpus).—Macfie, 1937, Ann. Mag. Nat. Hist., vol. 20, p. 7 (female; Trinidad).—Floch and Abonnenc, 1942, Inst. Pasteur Guyane Terr. l'Inini, publ. 37, p. 3 (French Guiana; fig. wing, palpus).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 14 (St. Croix, Barbados, Venezuela; fig. palpus).—Macfie, 1948, Ann. Trop. Med. Parasit., vol. 42, p. 86 (Chiapas, Mexico, notes).—Barbosa, 1952, Novas Subsídios . . . *Culicoides Neotropicos*, p. 12 (Argentina, Brazil; fig. palpus).

FEMALE: Length of wing 0.80 (0.66–0.92, $n=38$) mm.

Head.—Eyes broadly separated, with very short interfacetal hairs, appearing bare in profile of eye. Antenna with flagellar segments in proportion of 15:12:13:15:15:15:15:15:16:18:18:29, antennal ratio 0.83 (0.76–0.90, $n=13$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 7:19:24:8:8, third segment moderately swollen, 2.2 (1.6–2.6, $n=35$) times as long as greatest breadth, with small, deep sensory pit. Mandible with 15 (12–19, $n=37$) teeth.

Thorax.—Mesonotum pruinose dark grayish brown with moderately strong pattern of subshining, brownish black, consisting of a median anterior triangular marking and a sublateral pair of elongate, tri-

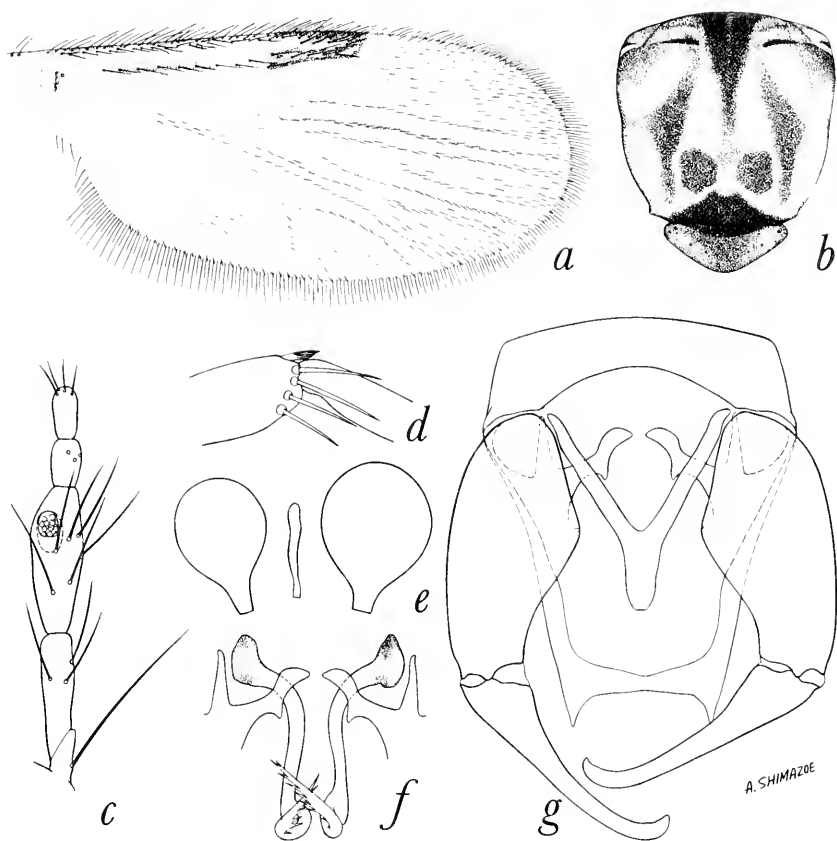


FIGURE 79.—*Culicoides debilipalpis* Lutz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

angular patches, widest at the suture. Scutellum, postscutellum and pleuron brownish black. Legs dark brown; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=37$) spines, the one next to the spur longest.

Wing.—Pattern as figured; the two poststigmatic pale spots in cell R_5 usually well separated, the posterior one located slightly proximad of the anterior one; distal pale spot in cell R_5 usually transverse to slightly reniform; two pale spots in cell M_1 ; one pale spot each in apices of cell M_2 and anal cell; pale spots present behind medial fork and in front of mediocubital fork, the latter absent in some specimens. Macrotrichia numerous, extending proximad to base of wing in a double row in cell M and numerous in anal cell;

costa extending to 0.65 (0.59–0.68, $n=37$) of distance to wing tip. Halter brownish, the flat end pale.

Abdomen.—Blackish, cerci yellowish. Spermathecae two, pyriform, unequal, measuring 0.060 by 0.039 mm. and 0.050 by 0.032 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with broad, very shallow caudo-median excavation; ninth tergum long and tapering with short, triangular, apicolateral processes. Basistyle with foot-shaped ventral root, dorsal root slender; dististyle slender and curving. Aedeagus with basal arch extending to more than two-thirds of total length, the mesal apex of arch narrow, the basal arms straight; distal stem pointed apically without apparent subapical projections. Parameres each with knobbed base, stem bent near base, very slender and straight in midportion, with a well-developed ventral pouch, distal portion not greatly elongated, with pointed apex and 4–4 lateral barbs.

DISTRIBUTION: Brazil; British Guiana; Cuba (La Lollisa); Ecuador; French Guiana; Guatemala; Honduras (Lancetilla, Tela); Nicaragua (Guapinula); Panama; Trinidad; Venezuela.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Farfan Beach, Fort Clayton, Fort Davis, Fort Kobbe, Fort San Lorenzo, Huile Sia Clara (?), Las Cruces, Loma Boracho, Mindi Dairy, Mojinga Swamp.

CHIRIQUÍ PROVINCE: Pedregal.

COCLÉ PROVINCE: Aguadulce, Puerto Farallón, Río Hato.

HERRERA PROVINCE: Chitré.

LOS SANTOS PROVINCE: Guararé, Las Tablas, Puerto Mensabé.

PANAMÁ PROVINCE: Isla Taboga, Pacora.

DISCUSSION: Through the courtesy of Dr. A. da Costa Lima, of the Instituto Oswaldo Cruz in Rio de Janeiro, we have been able to examine three slides from the original cotype series of *debilipalpis* Lutz. On one slide—from Amazonas de Cima, 1913, Lutz—are four females with the following characters: wing length 0.68 (0.66–0.69, $n=3$) mm., costal ratio 0.62; eyes broadly separated, with short interfacetal hairs; antenna with flagellar segments in proportion of 14:10:11:12:13:13:13:13:14:15:16:22, antennal ratio 0.81, distal sensory tufts present on segments III, VIII–X; palpal segments in proportion of 8:17:22:9:11, third segment 2.2 times as long as broad with a deep, small pit; mandible with 18, 20 ($n=2$) teeth; spermathecae measuring 0.050 by 0.034 mm. and 0.043 by 0.037 mm. These specimens conform well to the diagnosis of the species based on our Panama material and give reasonable assurance of the correctness of our determination. The other two slides are of a specimen remounted by Costa Lima for his 1937 paper (slides 2828 and 2829 made from preparation No. 2411), with the wings on one slide and

the remaining parts on another, no locality given. This specimen differs slightly from the others, being larger, wing 0.83 mm. long; mandible with 21 teeth; third palpal segment 2.5 times as long as broad; antennal segments III–XIII in proportion of 15:13:13:13:13:13:15:16:16:18, sensoria present on segments III and VIII–X on one side and III, VII–X on the other. We believe that this specimen would still fall within, and extend slightly in some characters, the range of variation found in *debilipalpis*.

The wing pattern of *debilipalpis* is similar to that of *equatoriensis* Barbosa, *germanus* Macfie, *hoffmani* Fox, *imitator* Ortiz, *insinuatus* Ortiz and Leon, and *trilineatus* Fox, all with one pale spot in apices of cell M_2 and anal cell, two pale spots in cell M_1 , no pale spots at the wing margin at the apices of the veins, the distal pale spot in cell R_5 not very large nor meeting anterior wing margin and the poststigmatic pale spots usually separate, with the posterior one lying slightly proximad of the anterior one. These species all have rather hairy wings, two spermathecae present, the antenna with segment XI not conspicuously shorter nor longer than segment X and distal sensory tufts present on segments III, VIII, IX and X.

In *hoffmani* the macrotrichia are usually confined to the distal half of the wing, the third palpal segment is broader with a broader pit, the eyes are more distinctly hairy and the male genitalia have the aedeagus trilobed and the parameres lack the ventral lobes. In *imitator* Ortiz the posterior poststigmatic pale spot in cell R_5 is located distad of the anterior one, the pale spot lying in front of the medio-cubital fork is lacking and the third palpal segment lacks a definite sensory pit. *Culicoides germanus* and *insinuatus* have a similar wing pattern but the anterior femora are dark in *insinuatus* and the fore and mid legs are dark in *germanus*, and in *germanus* the posterior poststigmatic pale spot lies far proximad of the anterior one and there are sensoria present on antennal segment VII. *Culicoides equatoriensis* Barbosa from Ecuador resembles *hoffmani* and *germanus* in wing markings, in the restriction of the macrotrichia to the distal half of the wing, and in the broad, shallow, palpal pit, but differs from these species and from *debilipalpis* in having the eyes bare and contiguous and the knees bordered by pale rings on both sides on all three pairs of legs. *Culicoides trilineatus* has an even hairier wing than *debilipalpis*, but the pale spots in cell M_1 and the distal one in cell R_5 are much smaller, the mesonotum has a pattern of narrow dark lines, the third palpal segment is even longer and more slender, the mandible has more teeth (18) and antennal sensoria extend proximad to the fifth or sixth segment.

Other species with similar wing pattern and macrotrichia extending to the base of cell M are *transferrans* Ortiz and *rangeli* Ortiz and Mirsa,

but these species have one spermatheca, two pale distal spots in the anal cell, and the five distal antennal segments much elongated and bearing sensoria.

77. *Culicoides mirsae* Ortiz

FIGURE 80

Culicoides mirsae Ortiz, 1953, Rev. Sanid. Asist. Soc., vol. 18, p. 801 (female; Venezuela; fig. wing).

FEMALE: Length of wing 0.78 (0.76–0.82, $n=3$) mm.

Head.—Eyes narrowly separated, with long interfacetal hairs. Antenna with flagellar segments in proportion of 17:15:16:17:16:14:15:15:15:15:17:16:25, antennal ratio 0.70; distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 7:17:21:7:8, third segment moderately swollen, 2.1 times as long as greatest breadth, with a broad, deep sensory pit. Mandible with 16 teeth.

Thorax.—Mesonotum uniformly dark brown without prominent pattern. Scutellum, postscutellum and pleuron dark brown. Legs dark brown; fore and mid femora with subapical, all tibia with sub-basal and hind tibia with (3 specimens) or without (2 specimens), narrow distal pale rings; hind tibial comb with four spines, the one next to the spur longest.

Wing.—Pattern as figured, the pale spot at r-m crossvein very small and round and lying entirely distad of the crossvein in cell R_5 ; the two

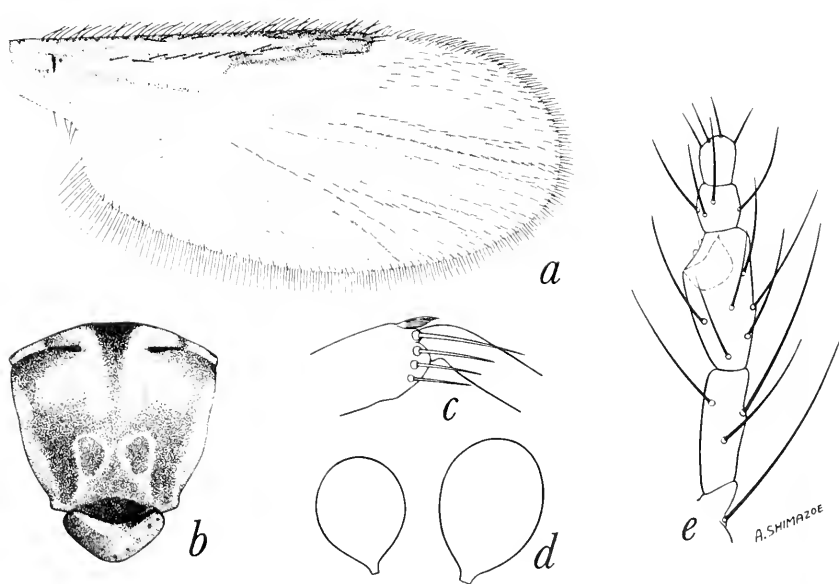


FIGURE 80.—*Culicoides mirsae* Ortiz, female: a, wing; b, thoracic pattern; c, tibial comb; d, spermathecae; e, palpus.

poststigmatic spots in cell R_5 small and well separated, the posterior one well proximad of the anterior one, distal pale spot in cell R_5 small and transverse; two pale spots in cell M_1 and two in the apex of anal cell; only one pale spot in distal part of cell M_2 , a pale spot in cell M_4 , one lying behind medial fork, and one lying in front of medio-cubital fork. Macrotrichia numerous on distal half of wing, in some specimens extending proximad in a double row to base of cell M and numerous in anal cell; costa extending to 0.60–0.62 ($n=2$) of distance to wing tip. Halter dull yellowish, the base of the knob brownish.

Abdomen.—Brownish black; cerci yellowish. Spermathecae two, ovoid, unequal, measuring 0.053 by 0.038 and 0.036 by 0.026 mm., the bases of the ducts not sclerotized.

MALE: Unknown.

DISTRIBUTION: Venezuela; Panama; Trinidad (St. Patrick Estate).

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

DISCUSSION: The location of the small pale spot, not over the r-m crossvein, but entirely distad of it in cell R_5 , is unique and will readily distinguish *mirsae*. The wing pattern is similar to that of *debilipalpis* Lutz, but that species has only one pale distal spot in the anal cell; the wing of *castillae* Fox is also similar but has the apex of vein M_1 pale margined and two pale spots in the distal part of cell M_2 . *Culicoides mirsae* is quite rare, our series consisting of only three females from Almirante, taken in light traps in November, December and January, and two females from Trinidad (St. Patrick Estate, Arima), Dec. 24, 31, 1954, Aitken and Downs, collectors, in tree station.

78. *Culicoides aureus* Ortiz

FIGURE 81

Culicoides aureus Ortiz, 1951, Rev. Sanid. Asist. Soc., vol. 16, p. 585 (male; San Felipe, Yaracuy, Venezuela; fig. wing, palpus, mesonotum, genitalia).—Fox, 1955, Journ. Agr. Univ. Puerto Rico, vol. 39, p. 228 (synonym, *miyamotoi* Wirth and Blanton).

Culicoides miyamotoi Wirth and Blanton, 1953, Journ. Parasit., vol. 39, p. 231 (male, female; Panama; fig. wing, mesonotum, palpus, male genitalia).

FEMALE: Length of wing 0.89 (0.86–0.92 $n=3$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 17:14:15:16:16:15:16:17:16:16:18:19:27, antennal ratio 0.76; distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 11:19:24:8:9, third segment moderately swollen, 2.1 (1.8–2.5, $n=3$) times as long as greatest breadth, with a large, deep sensory pit opening by a small pore. Mandible with 18 ($n=3$) teeth.

Thorax.—Mesonotum yellowish brown, with a prominent pattern of punctiform brown dots at the seta-bases, more or less confluent in narrow irregular bands and lines, especially along a pair of sublateral, longitudinal lines. Scutellum narrowly dark brown in middle, yellowish on sides; postscutellum dark brown; pleuron yellowish above,

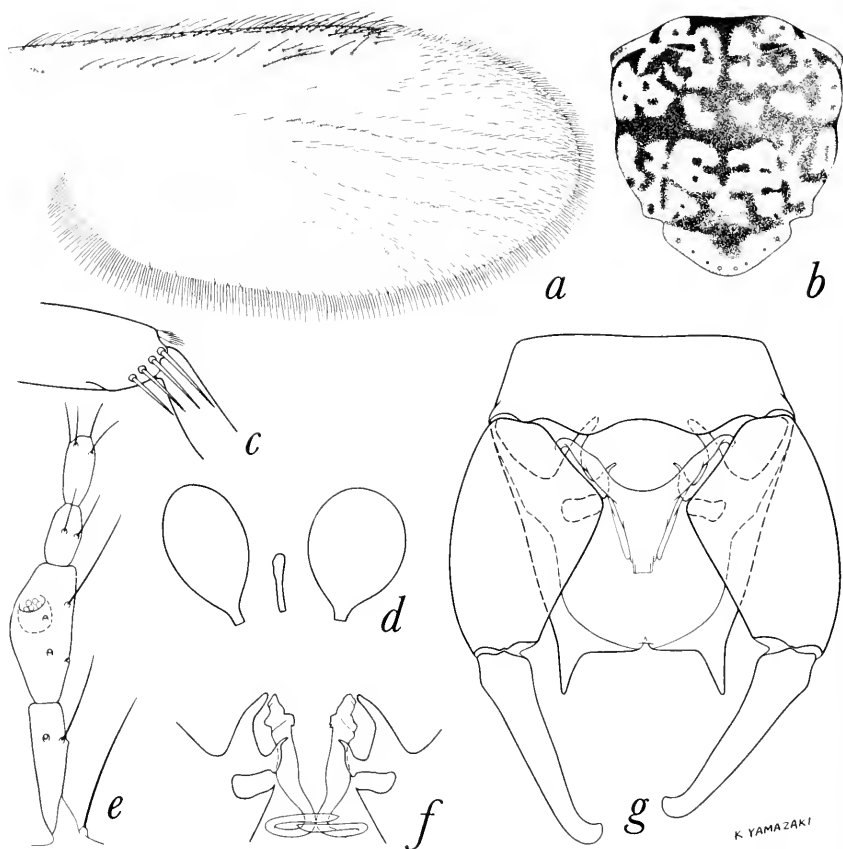


FIGURE 81.—*Culicoides aureus* Ortiz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, tibial comb; *d*, spermathecae; *e*, palpus. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

dark below. Legs brown with knee spots black, broad pale bands at bases and just before apices of femora, at bases of tibiae and at apex of hind tibia; hind tibial comb with four ($n=3$) spines, the one nearest the spur longest.

Wing.—Pattern as figured, the membrane grayish with very prominent, small, milky white spots; second radial cell very dark; pale spot over r-m crossvein narrow, continued in full breadth to costal margin; cell R_5 with five small pale spots—one lying on anterior side of vein M_1 at base of cell, and four lying in an irregular oval group in middle of cell, of the four, a round one lies at costal margin just beyond second radial cell, two round ones lie behind second radial cell, and a crescent-shaped one, the convex side distad, lies across subapical part of cell; apices of veins M_1 , M_2 , M_{3+4} and Cu_1 pale; two small round pale spots in cell M_1 , the distal one lying far from wing margin; pale spot in apex of cell M_2 and in cell M_4 lying far from wing margin; only one pale spot in distal part of anal cell; cell M_2 with a linear spot lying in front of convex part of vein M_{3+4} , a pale spot lying in front of mediocubital fork, one lying behind medial fork, one extending across middle of stem of mediocubitus and one extending to base of wing over base of medial vein. Macrotrichia moderately numerous on distal half of wing, barely extending to apex of anal cell; costa extending to 0.63 ($n=3$) of distance to wing tip. Halter pale, anterior side of knob brownish.

Abdomen.—Spermathecae two, subequal, pyriform, with short sclerotized necks.

MALE GENITALIA: Ninth sternum with a very slightly perceptible caudomedian excavation; ninth tergum slightly tapered, with long, pointed, apicolateral processes. Basistyle with ventral lobe foot-shaped, the posterior heel not developed, dorsal root longer and slender; dististyle slender, nearly straight with slender rounded tip slightly bent. Aedeagus with low, broad, mesally rounded basal arch extending to a third of total length of aedeagus, basal arms stout, distal portion slightly tapered to a slender, truncated apex. Parameres each with basal knob, stem nearly straight and very slightly swollen to midlength, without ventral lobe, distal portion long and narrowed gradually to simple, recurved, flattened points.

DISTRIBUTION: Venezuela; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Clayton, Fort Davis, Fort Gulick, Fort Sherman, Loma Boracho, Mojinga Swamp.

DISCUSSION: This species closely resembles *ginesi* Ortiz in mesonotal and wing markings, and the two apparently are closely related, but *ginesi* has much different male genitalia (similar to those of *hoffmani* Fox), only three pale spots in a triangle in cell R_5 , and the apices of the wing veins not pale at the wing margin.

79. *Culicoides ginesi* Ortiz

FIGURE 82

Culicoides ginesi Ortiz, 1952, Rev. Sanid. Asist. Soc., vol. 16, p. 586 (female; San Felipe, Yaracuy, Venezuela; fig. wing, palpus, antenna, spermatheca).

FEMALE: Length of wing 0.80 (0.73–0.89, $n=10$) mm.

Head.—Eyes nearly contiguous, without interfacetal hairs. Antenna with flagellar segments in proportion of 16:14:14:14:14:13:13:13:14:14:14:14:26, antennal ratio 0.74; distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 7:15:22:7:10, third segment moderately swollen, 2.0 (1.6–2.3, $n=10$) times as long as greatest breadth, with a small, deep sensory pit. Mandible with 17 (16–19, $n=7$) teeth.

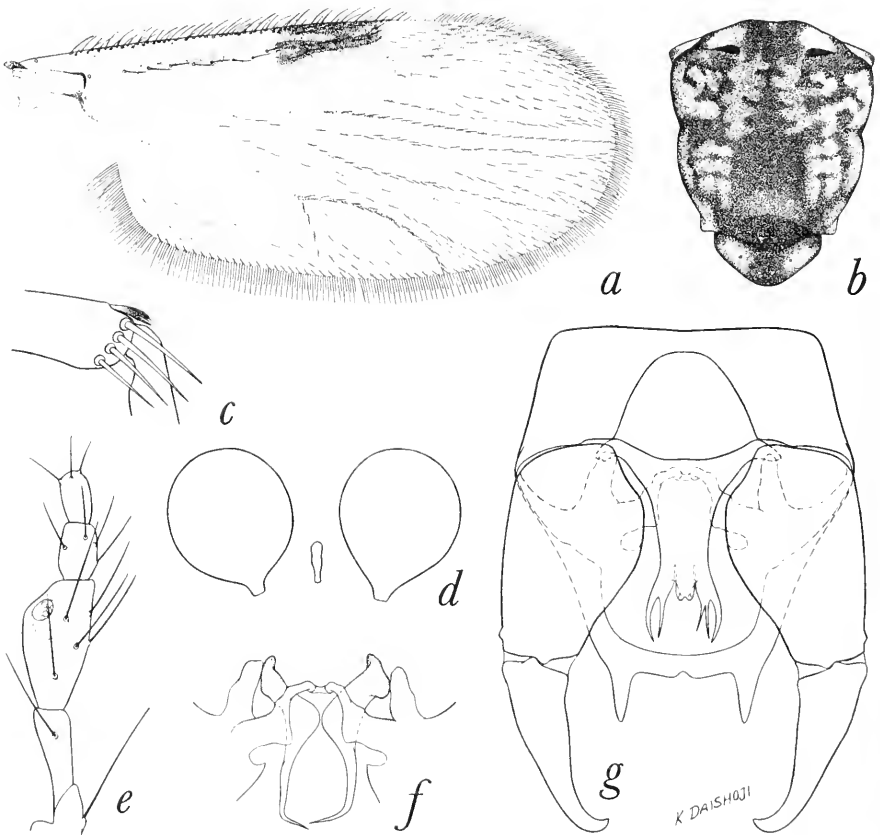


FIGURE 82.—*Culicoides ginesi* Ortiz. a–e, Female: a, wing; b, thoracic pattern; c, tibial comb; d, spermathecae; e, palpus. f, g, Male: f, parameres; g, genitalia, parameres removed.

Thorax.—Mesonotum pruinose yellowish brown, with irregular pattern of dark brown dots at seta bases and splotches from their occasional fusion. Scutellum pale on sides, brown in middle; post-scutellum dark brown, pleuron yellowish with a broad, transverse, brown band. Legs brown, femora with broad basal and subapical pale bands, all tibiae with broad subbasal and fore and mid tibiae with broad apical pale bands; tarsi pale, hind tibial comb with four ($n=9$) spines, the two nearest the spur longest, subequal.

Wing.—Pattern as figured; cell R_5 with three well-separated spots arranged in a triangle; two pale spots in cell M_1 , one each in distal portions of cells M_2 , M_4 and anal cell, all lying distant from wing margin; pale spot present lying behind medial fork and one lying ahead of mediocubital fork. Macrotrichia numerous on distal half of wing and a few extending in a double row to base of cell M and a few in anal cell; costa extending to 0.62 (0.59–0.68, $n=10$) of distance to wing tip. Halter pale.

Abdomen.—Brown, cerci pale. Spermathecae two, slightly ovoid, subequal, each measuring 0.047 by 0.034 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum broad, with a deep caudomedian excavation; ninth tergum short and tapering, with very long, triangular, apicolateral processes. Basistyle with foot-shaped ventral root, the posterior heel not developed, dorsal root shorter and stout; dististyle stout at base, tip slightly bent and slender. Aedeagus with very low basal arch, the basal arms short and stout, distal stem very broad and bearing apically two or three sublateral pairs of long, pointed, sclerotized processes in a distal row. Parameres each with stout basal knob, stem greatly swollen in basal portion, abruptly bent at most swollen portion, without ventral lobe, tapered distally to slender, simple, only slightly curved distal points.

DISTRIBUTION: Venezuela; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Clayton, Fort Davis, Fort San Lorenzo, Fort Sherman, Loma Boracho, Mojinga Swamp.

COCLÉ PROVINCE: Aguadulce.

LOS SANTOS PROVINCE: Puerto Mensabé.

PANAMÁ PROVINCE: Arraiján, Tocumen.

DISCUSSION: This very characteristic and strikingly marked species takes its place in the *debilipalpis* group, with wing, mesonotal and leg markings allying it with *aureus* Ortiz. The male aedeagus of *ginesi* bears distal processes similar to but more numerous and more extreme in development than those of *hoffmani*.

80. *Culicoides glabrior* Macfie

FIGURE 83

Culicoides debilipalpis var. *glabrior* Macfie, 1940, Ent. Monthly Mag., vol. 76, p. 27 (male, female; British Guiana).

Culicoides grahambelli Forattini, 1956, Proc. Ent. Soc. Washington, vol. 58, p. 35 (female; Cerro Cefa, Panama). New synonymy.

FEMALE: Length of wing 1.02 (0.86–1.22, $n=11$) mm.

Head.—Eyes bare, broadly contiguous. Antenna with flagellar segments in proportion of 20:15:15:15:16:16:16:16:18:19:21:22:36, antennal ratio 0.89 (0.80–0.99, $n=5$); distal sensory tufts present on segments III, VII–X. Palpal segments in proportion of 7:13:23:8:8, third segment broad, 1.9 (1.7–2.6, $n=5$) times as long as greatest breadth, with a very broad, shallow sensory pit; fourth segment much broader than fifth. Mandible with 15 (12–16, $n=11$) teeth.

Thorax.—Mesonotum shining dark brown, with faint pattern of dull, paler brown areas consisting of a median discal area from anterior third to scutellum and two pairs of small spots, one over humeral pits, the other at lateral margins at sutural level. Scutellum, post-

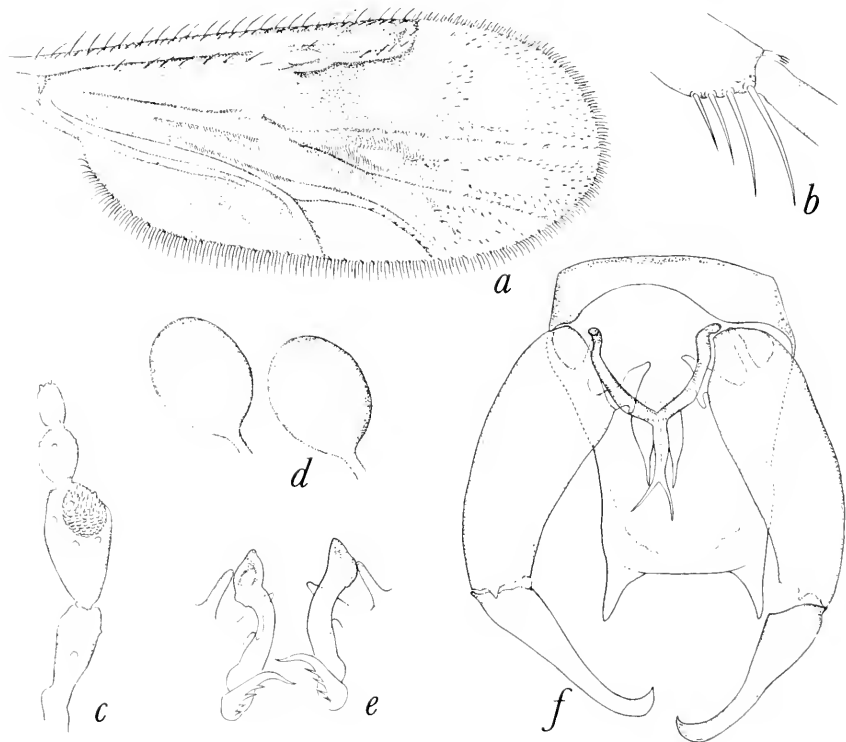


FIGURE 83.—*Culicoides glabrior* Macfie. a–d, Female: a, wing; b, tibial comb; c, palpus; d, spermathecae. e, f, Male: e, parameres; f, genitalia, parameres removed.

scutellum and pleuron dark brown. Legs dark brown, femora without pale rings, fore and mid tibiae with basal, and hind tibiai with basal and apical, narrow pale rings; hind tibial comb with four ($n=9$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell remarkably broadened, the three pale spots in cell R_5 arranged in a large triangle, distal spot in cell R_5 transverse, only one distal spot in cell M_2 , pale spots present behind medial fork and in front of mediocubital fork, a single pale spot in apex of anal cell transverse, extending nearly to wing margin. Macrotrichia sparse on distal half of wing, a few at base of medial cell and in anal cell; costa extending to 0.68 of distance to wing tip. Halter brown, the end of the knob slightly paler.

Abdomen.—Blackish, cerci yellowish. Spermathecae two, pyriform, subequal, measuring 0.063 by 0.048 mm. and 0.059 by 0.042 mm.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum long and tapering, the apicolateral processes large, triangular. Basistyle with ventral root foot-shaped, the posterior heel long; dorsal root short; dististyle long and slender, with bent, pointed apex. Aedeagus with short, rounded anterior arch, posterior portion in three parts; a median stem-like lobe with prominently bifurcate apex, and a pair of slender, tapering, pointed lateral lobes about half as long as median one. Parameres stout, each with large basal knob, stout stem gradually expanded to a large, ventral, subapical lobe, beyond which it is greatly narrowed, twisted laterad, ventrad, and then mesad, the distal point flattened with four subapical barbs.

DISTRIBUTION: British Guiana; Honduras (Lancetilla); Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Camp Piña, Fort Davis, Loma Boracho, Mojinga Swamp.

PANAMÁ PROVINCE: Goofy Lake, Pacora.

DISCUSSION: Through the courtesy of Paul Freeman and the trustees of the British Museum (Natural History) we have examined a slide labeled in Macfie's handwriting "*Culicoides* / *debilipalpis* Lz. / v. *glabrior* / ♀ (large specimen) / *C. germanus* / ♀," but not bearing locality or other data. According to Mr. Freeman these are the presumed types of *glabrior* and *germanus*, each of which Macfie described from single females from British Guiana. The type of *glabrior* agrees in all details very closely with our Panama series. *Culicoides glabrior* can readily be distinguished from all related species by the remarkable breadth of the second radial cell. The unbanded femora are also distinctive.

This species seems to occupy an intermediate position between the *fluvialis* and *debilipalpis* groups and its true relations are doubtful.

The *pachymerus* group

This group consists of small species with tawny yellowish mesonotum without prominent pattern, wing with pattern of oblique streaks and spots, with pale poststigmatic pale spot often encroaching on distal half of second radial cell; costa long, extending to 0.69–0.79 of distance to wing tip, second radial cell long and narrow, in *uniradialis* fused with the first radial cell; antenna with distal sensory tufts present on segments III, VIII–X; third palpal segment slender with small pit; legs stout, the femora markedly swollen; four tibial spines, two spermathecae; male genitalia with ventral root of basistyle foot-shaped; aedeagus stout; parameres with simple basal knob, long slender stem with or without ventral lobe or subapical spines.

PANAMA SPECIES: Four: *almirantei*, new species; *caprilesi* Fox; *pachymerus* Lutz, and *uniradialis* Wirth and Blanton. Also, *obnoxius* Fox from Venezuela apparently belongs to this group.

81. *Culicoides almirantei*, new species

FIGURE 84

FEMALE: Length of wing 0.79 (0.76–0.86, $n=8$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 15:10:9:9:10:11:12:13:16:17:20:24:31, antennal ratio 1.25 (1.21–1.29, $n=6$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 7:16:24:8:7, third segment moderately swollen, 2.1 (2.0–2.4, $n=10$) times as long as greatest breadth, with a broad, shallow sensory pit. Mandible with 15 (14–16, $n=5$) teeth.

Thorax.—Mesonotum pruinose grayish brown; anterior margin and two narrow longitudinal striae, each with broader lateral extensions at midlength, dark brown. Scutellum pruinose brown, darker narrowly in middle; postscutellum and pleuron dark brown. Legs brown; fore and mid femora with subapical, all tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with four ($n=10$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; large pale spot over r-m crossvein extending broadly to costal margin; poststigmatic pale spot in cell R_5 with narrow anterior extension to wing margin past second radial cell, greatly expanded and filling cell R_5 behind second radial cell to anterior side of vein M_1 ; distal pale spot in cell R_5 diamond-shaped, usually extending anterodistally to wing margin, leaving a very narrow, oblique dark mark proximad between it and poststigmatic pale spot; penultimate pale spots in cells M_1 and M_2 oval, largely filling the space between the adjacent veins; distal pale spot in cell M_1 usually broadly attaining wing margin; distal pale spots in cells M_2 and M_4

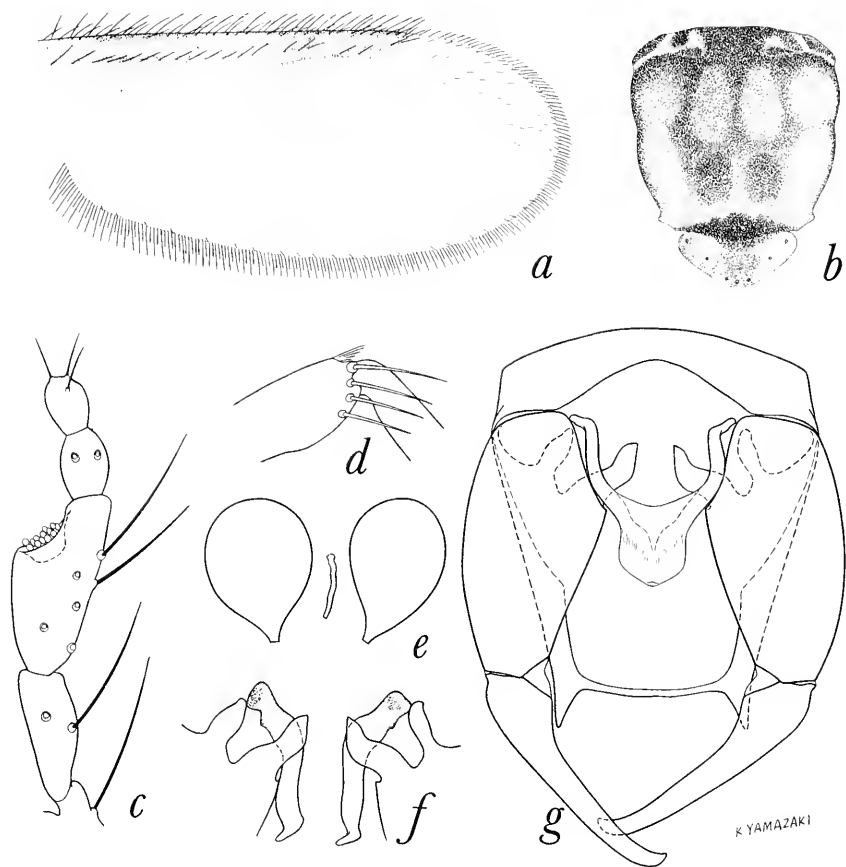


FIGURE 84.—*Culicoides almirantei*, new species. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

large and broadly attaining wing margin; two pale spots in distal part of anal cell; pale spots present lying in front of mediocubital fork and behind medial fork, connected to the penultimate pale spot in cell M_2 ; base of wing broadly pale from costal margin to base of anal cell. Macrotrichia very sparse in apices of cells R_5 and M_1 ; costa extending to 0.69 (0.64–0.74, $n=8$) of distance to wing tip. Halter yellowish.

Abdomen.—Brownish black, cerci pale. Spermathecae two, pyriform, subequal, measuring 0.048 by 0.035 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with a broad, shallow, caudo-median excavation; ninth tergum short with broad apex, caudal margin straight, apicolateral processes long and pointed. Basistyle with ventral root foot-shaped, the posterior heel poorly developed, dorsal root stout; dististyle nearly straight with slender tip. Aedeagus

with rounded basal arch to slightly over half of total length of aedeagus, basal arms stout and curved; distal portion in form of a poorly sclerotized, apically rounded, flattened lobe with a more heavily sclerotized median slender stem. Parameres each with basal knob, stem short and stout, abruptly bent near base, ventral lobe absent, distal portions apparently damaged, characters not certain.

DISTRIBUTION: Panama.

SPECIMENS EXAMINED: Holotype female (USNM 63172), Almirante, Bocas del Toro Province, Panama, mile 2.04, Apr. 15, 1953, F. S. Blanton, light trap. Allotype male, Almirante, November 1952. Paratypes, 37 females, same data as type, except miles 2.04 to 7.04 and dates Apr. 14 to 29, 1953.

DISCUSSION: The wing pattern of *almirantei* is obviously related to those of *uniradialis* Wirth and Blanton, *caprilesi* Fox, and *pachymerus* Lutz, but in these species there is a tendency for the post-stigmatic pale area to encroach on the second radial cell which is over half pale in *pachymerus* and *uniradialis*. Moreover, the costa is much longer in *caprilesi* and *uniradialis*, and in the latter species there is a complete fusion of the two radial cells. In all three related species the distal antennal segments are much shorter than in *almirantei* and in this character the present species seems best to express its individuality. The male genitalia of the four species are of the same type, each with distinct characters; *caprilesi* most greatly resembling *almirantei* in male characters, as well as in the greatest darkening of the second radial cell of the wing. *Culicoides lopesi* Barretto from São Paulo, Brazil, known only from the male, has a wing nearly identical with that of *almirantei*, but the genitalia are quite different, with a tapering ninth tergum, aedeagus with slender basal arms and slender apex, and parameres with a low ventral lobe and subapical barbs. *Culicoides obnoxius* Fox from Venezuela, known only from the female, has a similar wing pattern also, but in that species the apex of the second radial cell is pale, apex of vein M_1 is pale, the eyes are widely separated with short interfacetal hairs and the five distal antennal segments are much more elongated.

82. *Culicoides caprilesi* Fox

FIGURE 85

Culicoides caprilesi Fox, 1952, Ann. Ent. Soc. Amer., vol. 45, p. 364 (female; Mt. Marachuaca, Venezuela; fig. wing, palpus, antenna, eyes, tibial comb, spermathecae).

Culicoides kintzi Wirth and Blanton, 1953, Journ. Washington Acad. Sci., vol. 43, p. 72 (male, female; Panama; fig. wing, palpus, spermathecae, male genitalia). —Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 114 (notes). New synonymy.

FEMALE: Length of wing 0.83 (0.73–0.98, $n=6$) mm.

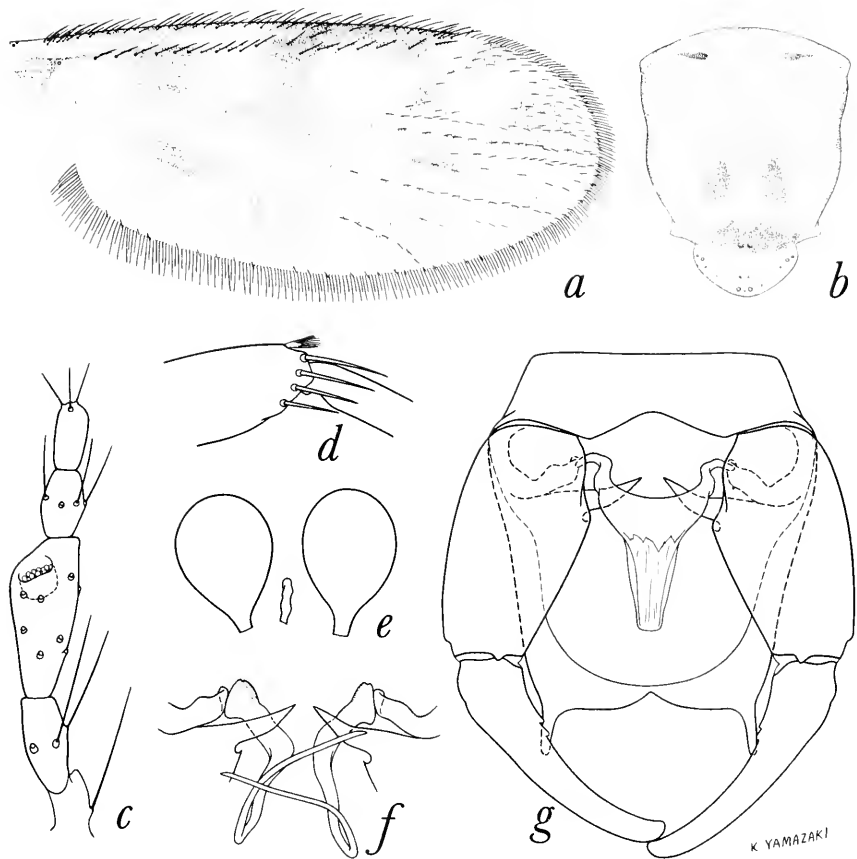


FIGURE 85.—*Culicoides caprilesi* Fox. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Head.—Eyes very broadly separated, bare. Antenna with flagellar segments in proportion of 18:15:16:16:16:16:16:16:16:16:14:18, antennal ratio 0.61 (0.58–0.65, $n=3$); distal sensory tufts present on segments III, VIII–X, sometimes absent on VIII. Palpal segments in proportion of 7:15:20:8:10, third segment very slightly swollen, 2.0 (1.6–2.3, $n=4$) times as long as greatest breadth, with a small, shallow sensory pit. Mandibles with 16–17 ($n=2$) teeth.

Thorax.—Mesonotum and scutellum tawny, yellowish brown; mesonotum with irregular anterior areas and three very narrow longitudinal striae brownish. Postscutellum and pleuron brown. Legs yellowish; knee spots and broad median bands on femora and tibiae brownish; hind tibial comb with four ($n=6$) spines, the one nearest the spur longest. Legs stout, fore and hind femora particularly swollen.

Wing.—Pattern as figured, pale spot over r-m crossvein large, broadly extending to costal wing margin; second radial cell dark to apex, the dark area extending caudad from tip of cell as a small round spot in cell R_5 which sometimes is connected to the oblique distal dark mark in cell R_5 ; poststigmatic pale spot in cell R_5 thus often divided into an anterior small pale spot at tip of second radial cell and a large posterior spot extending from posterior edge of second radial cell at midlength to vein M_1 ; distal pale spot in cell R_5 with a narrow anterodistal extension curving to wing margin and following it narrowly to wing tip; two large, elongate pale spots in cell M_1 ; two pale spots in distal portion of cell M_2 , the proximal one connected to a large pale area between medial and mediocubital forks and then to pale area at wing base; pale spot in cell M_4 large; a single pale spot in apex of anal cell narrowly if at all connected to wing margin; base of wing with broad pale area. Macrotrichia sparse but well scattered on distal half of wing; costa extending to 0.78 ($n=3$) of distance to wing tip; second radial cell not reduced to a narrow slit or obsolete as in *pachymerus*. Halter pale.

Abdomen.—Grayish brown, yellowish at base above. Spermathecae two, pyriform, subequal, measuring 0.043 by 0.034 mm. and 0.041 by 0.029 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with very shallow, caudomedian excavation; ninth tergum short and broad, with very long, slender apicolateral processes and a distinct mesal notch at apex. Basistyle with ventral root foot-shaped, the posterior heel vestigial, the toe slender and pointed; dorsal root very short and stout; dististyle slightly curved, gradually tapered to stout, blunt apex. Aedeagus stocky, basal arch very low and broad, basal arms stout and abruptly bent, distal portion tapered to bluntly rounded apex. Parameres each with basal knob, stem slender, abruptly bent near base, tapering distally without ventral lobe, the ventrally distal portion very long, tapered to simple, slender point.

DISTRIBUTION: Venezuela; Panama.

PANAMA RECORDS:

CANAL ZONE: Fort Sherman, Madden Dam, Mojinga Swamp (type locality of *kintzi*).

CHIRIQUÍ PROVINCE: Río Tabasará.

DARIÉN PROVINCE: Garachiné, Punta Patiño.

VERAGUAS PROVINCE: Las Palmas.

DISCUSSION: Through the courtesy of Dr. Irving Fox of the University of Puerto Rico we have examined the type slide of *caprilesi*, which is in good condition, and we have been able to determine by direct comparison that *kintzi* Wirth and Blanton is a synonym. *C. caprilesi* is closely related to *pachymerus* Lutz, but can be distinguished

readily in pinned mounts by the greater development of the dark mesonotal striae, and the much hairier wing on which the dark color pattern is more extensive. On the wing there is a dark mark extending from the base of the second radial cell almost to its apex and extending over into cell R_5 as a small rounded dark spot just behind the tip of the second radial cell. In some specimens the latter dark spot is narrowly connected to the next distal dark area as figured by Fox for *caprilesi*. *C. almirantei*, new species, is also closely related, having the second radial cell entirely dark, but it can be separated from *caprilesi* by its long distal antennal segments (antennal ratio, 1.25) and shorter costa (to 0.69 of wing length).

83. *Culicoides pachymerus* Lutz

FIGURE 86

Culicoides pachymerus Lutz, 1914, Mem. Inst. Oswaldo Cruz, vol. 6, p. 83 (female; Rio Negro, Brazil; fig. wing, leg).—Costa Lima, 1937, idem., vol. 32, p. 421 (unrecognizable).—Wirth, 1955, Proc. Ent. Soc. Washington, vol. 57, p. 112 (questionable identification, descriptive notes; Guatemala; fig. palpus).

FEMALE: Length of wing 0.72 (0.67–0.76, $n=7$) mm.

Head.—Eyes very broadly separated, bare. Antenna with flagellar segments in proportion of 16:13:13:14:14:14:14:14:13:14:13:22, antennal ratio 0.66 (0.62–0.71, $n=5$); distal sensory tufts present on segments III, IX and X, rarely on VIII. Palpal segments in proportion of 5:11:18:6:10, third segment very slightly swollen, 1.8 (1.6–2.1, $n=7$) times as long as greatest breadth, with a small, shallow sensory pit. Mandible with 14 (11–18, $n=8$) teeth.

Thorax.—Mesonotum and scutellum uniform tawny yellowish brown, with vestiture of short appressed yellowish hairs. Post-scutellum and pleuron brownish. Legs yellowish, femora and tibia with very faint, broad, median brownish bands; hind tibial comb with four ($n=6$) spines, the one nearest the spur longest; legs stout, fore and hind femora greatly swollen, fusiform, slightly flattened laterally.

Wing.—Pattern as figured; pale spot over r-m crossvein large and broadly meeting costal wing margin; poststigmatic pale spot in cell R_5 including distal half of vein R_{4+5} , the extremely long and narrow second radial cell thus appearing pale on distal half; the poststigmatic pale spot narrow in cell R_5 distal to end of costa, extending obliquely proximad and greatly broadened posteriorly to vein M_1 behind second radial cell; distal pale spot in cell R_5 varying in extent, usually oval in shape and not attaining wing margin, but in some specimens with a narrow anterior extension extending distad to wing tip; two elongated pale spots in cell M_1 ; two pale spots in distal portion of cell M_2 ; pale spot in cell M_4 nearly filling cell; anal cell with large pale

spot filling apex of cell to wing margin; area between medial and mediocubital forks continuously pale, connected by a pale line to broad basal pale area of wing. Costa extending to 0.71 (0.69–0.74, $n=7$) of distance to wing tip; second radial cell extremely long and narrow, appearing obsolete in most specimens; macrotrichia very sparse, confined to a few in apices of cells R_5 and M_1 . Halter pale.

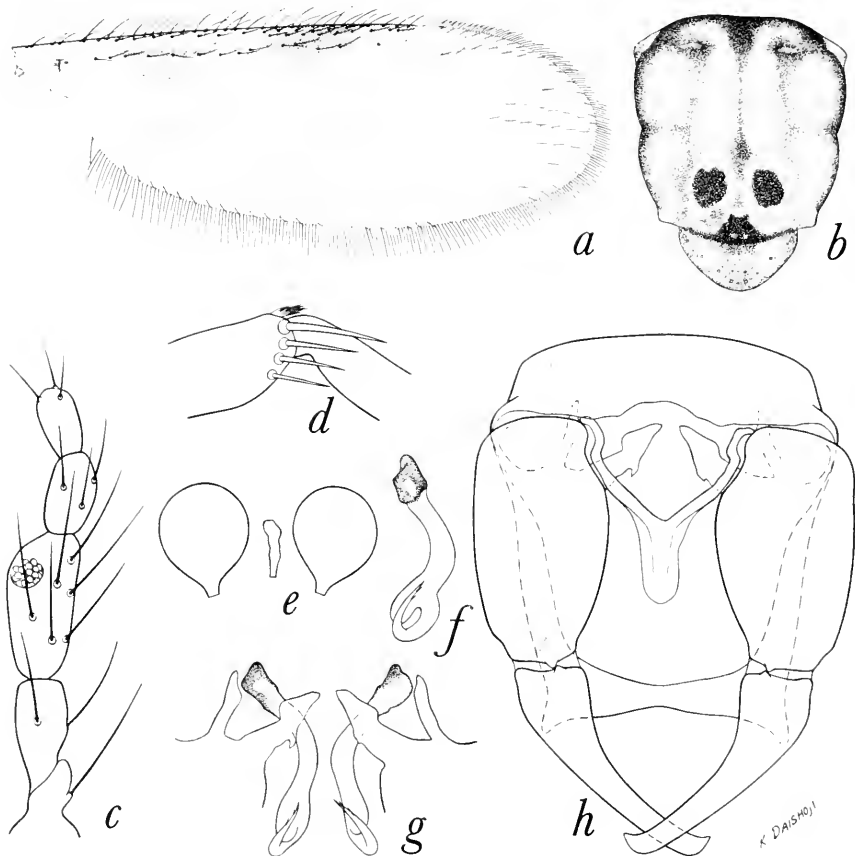


FIGURE 86.—*Culicoides pachymerus* Lutz. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f-h*, Male: *f*, paramere, lateral view; *g*, parameres; *h*, genitalia, parameres removed.

Abdomen.—Yellowish with brownish segmental, pleural and tergal spots. Spermathecae two, pyriform, subequal, relatively small, each measuring 0.036 by 0.026 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum short and quadrate, caudal margin some-

what indented mesad, the apicolateral processes moderately well developed, bluntly triangular. Basistyle with ventral root foot-shaped, the posterior heel very poorly developed, dorsal root slender; dististyle moderately stout distad with bluntly pointed apex. Aedeagus with basal arch low and broad, the basal arms bent in midportions, slender; distal apex with relatively slender, rounded tip. Parameres each with basal knob, stem slender and curved in midportion, ventral lobe very long, about two times as long as its diameter, apical portion of paramere very slender, tapered to simple point.

DISTRIBUTION: Brazil; Guatemala; Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Davis, Fort Sherman, Loma Boracho, Mojinga Swamp.

CHIRIQUÍ PROVINCE: David.

DARIÉN PROVINCE: El Real, Punta Patiño.

VERAGUAS PROVINCE: Las Palmas.

DISCUSSION: Through the courtesy of Dr. A. da Costa Lima we have been able to examine the slide on which are mounted the five cotype specimens of *pachymerus* described by Lutz from Rio Negro, Amazonas, Brazil. As previously remarked by Lutz and by Costa Lima in the publications cited, the condition of the slide is very poor since the liquid mounting medium has separated for the most part from the specimens, leaving them wet but not immersed in the liquid. The antennae and palpi are missing, as originally stated by Lutz. By dark-field illumination of the wing it is possible to make out something of the venation and color pattern, which agree so far as can be determined with that described above for the specimens from Guatemala and Panama, and are quite distinct from the characters of *uniradialis* Wirth and Blanton and *caprilesi* Fox. The wing length measures 0.80 mm. and the costal ratio is 0.69. We are thus able to conclude with fair assurance that our species is conspecific with Brazilian *pachymerus*.

Culicoides pachymerus is smaller than *uniradialis* and *caprilesi*, its wing is less hairy than that of *caprilesi*, there is no dark spot or connection immediately posterior to the end of the second radial cell as in *caprilesi*, and the last segment of the antenna is much longer than the tenth (22:14, compared with 18:16 in *caprilesi*). The male genitalia of *pachymerus* closely resemble those of *uniradialis*, with a long ventral lobe present on the parameres, but differing in having a median notch on the ninth tergum, aedeagal arch much broader with slender basal arms and no barbs on the tips of the parameres.

84. *Culicoides uniradialis* Wirth and Blanton

FIGURE 87

Culicoides uniradialis Wirth and Blanton, 1953, Journ. Washington Acad. Sci., vol. 43, p. 69 (male, female; Panama; fig. wing, palpus, male genitalia).

FEMALE: Length of wing 0.94 (0.89–0.99, $n=5$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 22:19:19:19:18:18:18:18:18:18:18:26, antennal ratio 0.65 (0.64–0.66, $n=2$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 9:18:24:10:10, third segment very slightly swollen, 2.0 (1.9–2.2, $n=5$) times as long as greatest breadth, with a small, shallow sensory pit. Mandible with 16 (16–17, $n=4$) teeth.

Thorax.—Mesonotum rather narrow, color uniformly light tawny brown, with numerous short, appressed, yellowish hairs. Scutellum

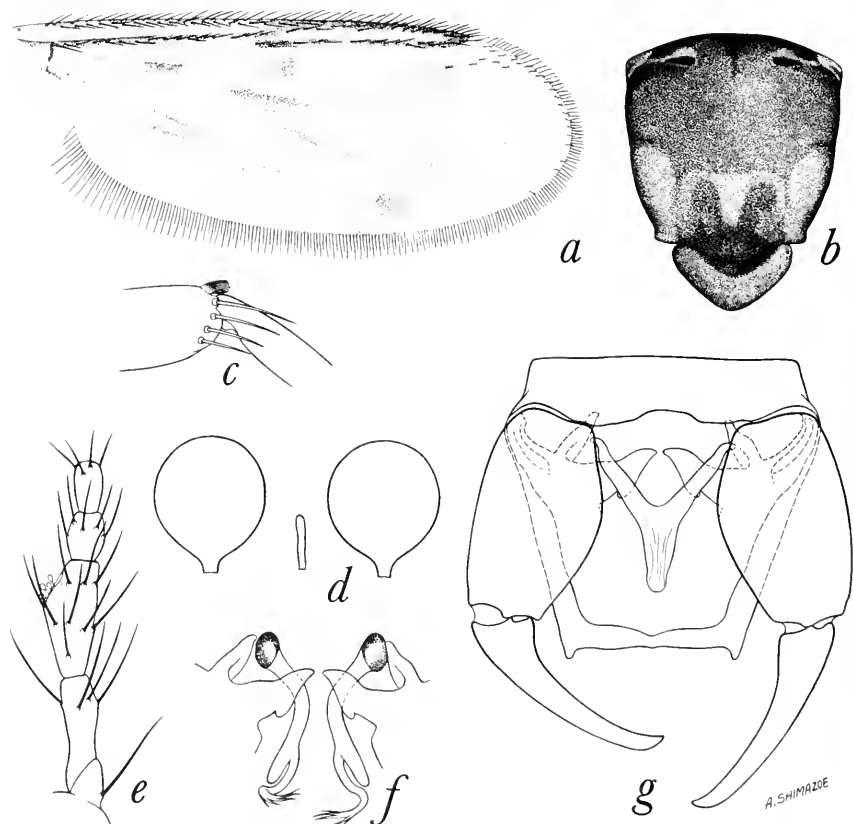


FIGURE 87.—*Culicoides uniradialis* Wirth and Blanton. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, tibial comb; *d*, spermathecae; *e*, palpus. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

tawny, postscutellum dark brown; pleuron pale with transverse area in middle darker. Legs pale brown, apical bands on all femora, basal and apical bands on tibiae and all of tarsi pale; all femora remarkably stout; hind tibial comb with four ($n=5$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; only one very elongate radial cell present; pale spots very extensive, interconnected, more than distal half of radial cell in pale area; dark markings of wing arranged in three transverse areas, the proximal one consisting of a dark spot from costa to media and a dark spot over stem of mediocubitus, both located slightly past midlengths of stems of these veins before the forks; second dark band narrower than pale areas on each side, consisting of an anterior spot extending from costa over base of radial cell to include the base of the medial fork, and a posterior spot over mediocubital fork following vein Cu_1 broadly to wing margin; third dark band beginning as an oblique, dark mark across middle of cell R_5 from wing margin near apex of cell, broadening toward vein M_1 and extending along this vein and forming a broad dark mark in front of its apex, continuing broadly across middle of cells M_1 and M_2 to apex of vein M_{3+4} and following vein M_2 also to its apex. Macrotrichia entirely absent; costa extending to 0.79 (0.78–0.81, $n=5$) of distance to wing tip. Halter pale.

Abdomen.—Brown. Spermathecae two, small, pyriform, slightly unequal, measuring 0.038 by 0.031 and 0.036 by 0.026 mm., the bases of the ducts sclerotized a very short distance.

MALE GENITALIA: Ninth sternum with very shallow caudomedian excavation; ninth tergum short, quadrate, with very small, widely separated, apicolateral processes. Basistyle with ventral root foot-shaped, the posterior heel a short, sharp spur, dorsal root short and relatively stout; dististyle nearly straight, gently tapered to tip which is blunt and slender but not bent. Aedeagus short and stout, basal arms stout and forming a V-shaped anterior arch to a half of total length of aedeagus; distal apex stout and rounded with faint serrations and apparently a few appressed, sharp, flattened, subapical spines. Parameres each with basal knob, stem slender, curved in midportion with a ventral lobe 1.5 times as long as its diameter, distal portion narrowed and tapered to sharp apical point with three or four subapical lateral barbs.

DISTRIBUTION: Panama.

PANAMA RECORDS:

BOCAS DEL TORO PROVINCE: Almirante.

CANAL ZONE: Fort Sherman, Loma Boracho, Mojinga Swamp (type locality).

CÓLON PROVINCE: Piña.

DARIÉN PROVINCE: Garachiné.

DISCUSSION: The remarkable extension of the costa to nearly eight-tenths of the wing length and the presence of only one radial cell which tapers evenly from the linear base to the apex, the absence of macrotrichia, and the larger size will readily separate *uniradialis* from the closely related *pachymerus* Lutz and *caprilesi* Fox.

The *arubae* group

This group consists of moderately large, stout species with mesonotal pattern of punctiform dots and black and white speckled wings; costa short, to 0.52 of wing length; a pair of distinct frontal tubercles present between antennal bases; antenna with short segments (antennal ratio, 0.87), distal sensory tufts present on segments III to X; tibial comb with seven spines, two spermathecae; male genitalia with ventral root of basistyle long and slender; paramere with basal knob directed sharply laterad, stem short and stout, the apex simple; aedeagus short and stout with reflexed basal arms, low basal arch and stout, truncated tip.

This group contains only one species, *arubae* Fox and Hoffman. It occurs in Panama.

85. *Culicoides arubae* Fox and Hoffman

FIGURE 88

Culicoides arubae Fox and Hoffman, 1944, Puerto Rico Journ. Pub. Health Trop. Med., vol. 20, p. 109 (male, female; Aruba, D. W. I.; fig. wing).—Barbosa, 1947, Anais Soc. Biol. Pernambuco, vol. 7, p. 11 (Canal Zone, Venezuela; fig. palpus, male genitalia).—Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 269 (male, female; Venezuela; fig. palpus, spermathecae, male genitalia).

FEMALE: Length of wing 1.17 (1.11–1.23, $n=3$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 22:13:13:13:13:12:12:11:15:15:16:17:32, antennal ratio 0.87; distal sensory tufts present on segments III to X. Palpal segments in proportion of 15:30:48:11:11, third segment swollen, 2.3 (2.1–2.7, $n=3$) times as long as broad, with a very broad, shallow sensory pit. Mandible with 15 (14–16, $n=5$) teeth.

Thorax.—Mesonotum very broad and convex; densely pale grayish pruinose; narrow median and two broader sublateral vittae indistinctly yellowish brown fumose; mesonotum with numerous punctiform brown dots at the seta bases. Scutellum narrowly dark brown in middle, yellowish white pollinose on sides; postscutellum grayish pollinose with two lateroposterior blackish spots; pleuron brownish black. Legs dark brown and distinctly annulated; narrow knee joints pale, knees with narrow blackish rings and then narrow pale rings on each side on femora and tibiae, femora narrowly pale at

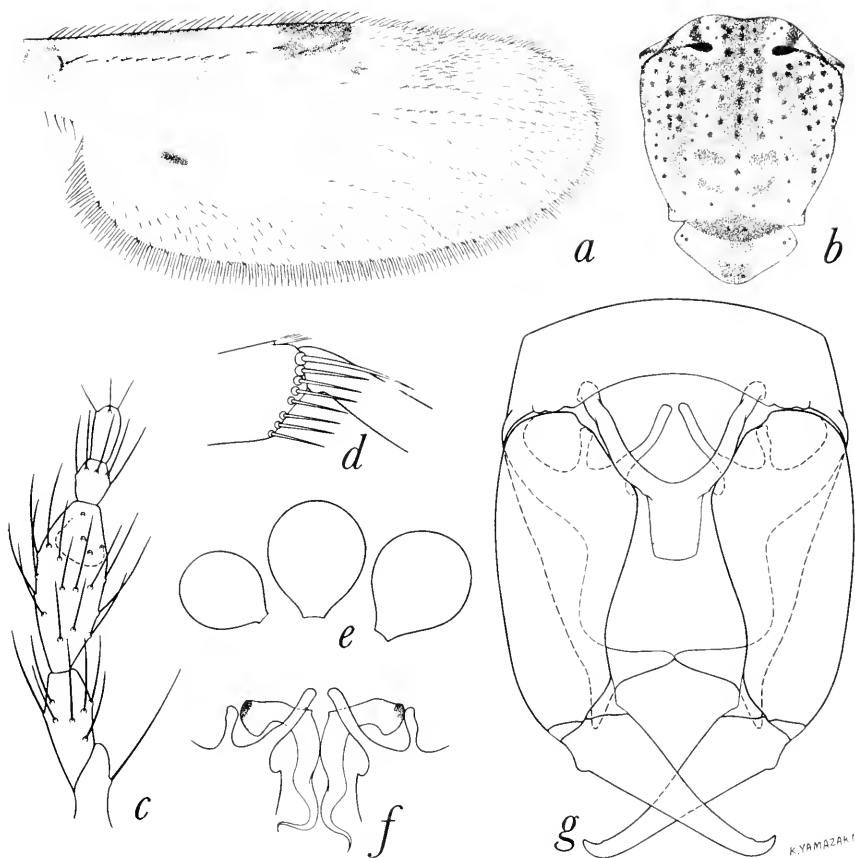


FIGURE 88.—*Culicoides arubae* Fox and Hoffman. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

bases, fore femur with narrow pale ring at midlength; hind tibial comb with 7-8 ($n=3$) spines, the one nearest the spur longest.

Wing.—Membrane milky white, with limited dark gray spots as figured, giving the appearance of blackish spots on a whitish ground; second radial cell blackish; veins pale margined; cell R_5 with a large pale spot surrounding a tiny black spot behind second radial cell, a broad V-shaped mark and a small distal round pale spot in apex of cell; cells M_1 and M_2 with three small round pale spots past level of forks; two pale spots in cell M_4 and two in distal portion of anal cell; base of wing extensively pale. Macrotrichia sparse but well scattered over wing, including anal cell; costa extending to 0.52 (0.51-0.54, $n=3$) of distance to wing tip. Halter knob blackish.

Abdomen.—Blackish. Spermathecae two (occasionally three, as figured), slightly unequal, ovoid, measuring 0.043 by 0.038 mm. and 0.038 by 0.029 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with a moderately deep caudomedian excavation; ninth tergum with distinct caudomedian notch, the apicolateral processes large and pointed. Basistyle with dorsal root short and stout, ventral root about twice as long, appearing extremely long and slender, dististyle stout at base, gradually tapered to very slender, pointed, bent tip. Aedeagus very broad and stout; basal arch extending to a third of total length; basal arms short and stout with a distinct, lateral, bent hook, distal portion with very broad, truncate tip. Parameres separate, each with a large, laterally directed basal knob, stem slender on lateral basal portion, abruptly bent with the straight longitudinal portion swollen basally, tapered to extremely fine, simple, recurved tip.

DISTRIBUTION:—Aruba; Venezuela; Panama.

PANAMA RECORDS:

CANAL ZONE: Ancón (May 18, 1914, S. T. Darling, outside house), Corozal (May 18, 1914, from ear of mule, S. T. Darling).

COCLÉ PROVINCE: Puerto Aguadulce.

HERRERA PROVINCE: Puerto Chitré.

LOS SANTOS PROVINCE: Guararé, La Palma, Las Tablas, Puerto Mensabé, Quemado.

VERAGUAS PROVINCE: Divisa.

DISCUSSION: *C. arubae* is not closely related to any other known species. In general appearance, with its pepper-and-salt wing pattern and broad, grayish brown mesonotum with pattern of punctiform brown dots, as well as the presence of frontal tubercles, it greatly resembles species of the *nubeculosus* group of the subgenus *Monoculicoides* Khalaf such as the North American *variipennis* (Coquillett), but all those species have but one elongate spermatheca and the male parameres fused. It is possible that *arubae* is a very primitive member of this group.

The *stigmalis* group

This group consists of moderately large species with pruinose, blackish mesonotum and bare, very poorly marked wing; second radial cell very long and narrow, forming a blackish stigma; antenna with sensoria present on segments III, VIII–X; four tibial spines; two spermathecae; male genitalia with ventral root of basistyle foot-shaped; apicolateral processes short; paramere with simple basal knob, stem straight without ventral lobe, the apex fringed; aedeagus with high, rounded basal arch and broad apex.

PANAMA SPECIES: One: *C. stigmalis* Wirth.

86. *Culicoides stigmatis* Wirth

FIGURE 89

Culicoides stigmatis Wirth, 1952, Journ. Parasit., vol. 38, p. 245 (female; Guatemala; fig. wing, palpus, spermathecae).—Vargas, 1953, Rev. Inst. Salub. Enf. Trop., vol. 13, p. 229 (male; Oaxaca, Mexico; fig. genitalia).

FEMALE: Length of wing 0.90 (0.88–0.92, $n=9$) mm.

Head.—Eyes narrowly separated, bare. Antenna with flagellar segments in proportion of 17:15:17:18:18:18:18:23:23:25:25:25, antennal ratio 0.91 (0.88–0.94, $n=8$); distal sensory tufts present on segments III, VIII–X. Palpal segments in proportion of 10:17:25:9:14, third segment short and scarcely swollen, 2.2 (2.0–2.5, $n=9$) times as long as greatest breadth, with a small, shallow sensory pit. Mandible with 14 (13–14, $n=3$) teeth.

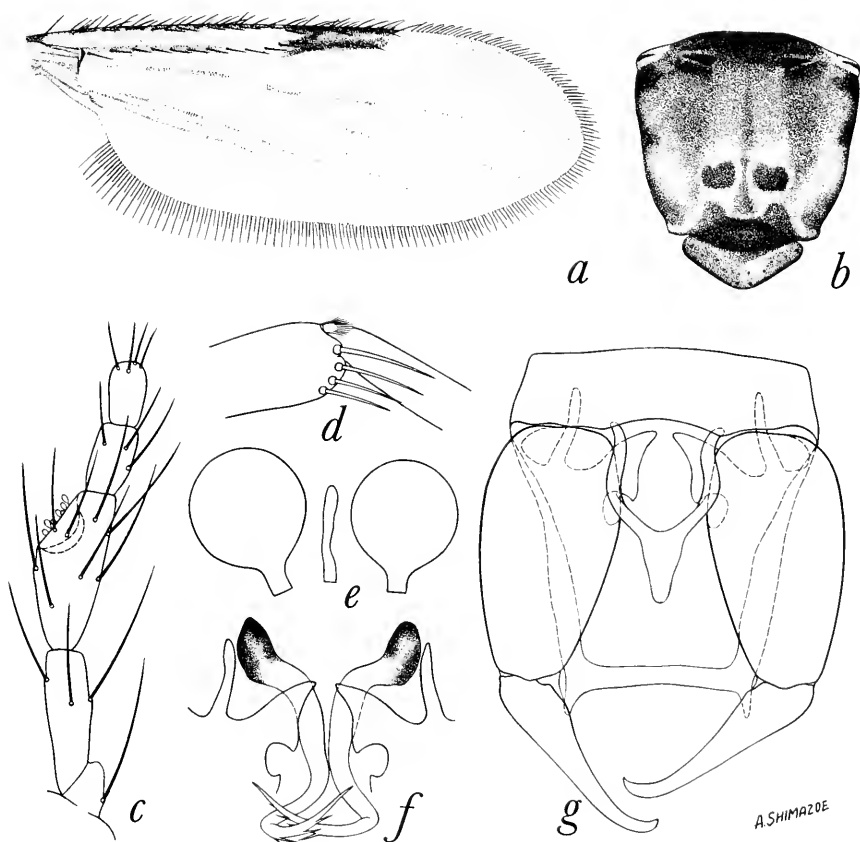


FIGURE 89.—*Culicoides stigmatis* Wirth. *a–e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

Thorax.—Mesonotum uniformly dull dark brown, almost black, with abundant vestiture of semi-appressed, fine, black hairs and coarse, suberect, black bristles. Scutellum, postscutellum and pleuron uniformly blackish. Legs uniformly dark brown, hind tibia with a faint basal pale ring; femora rather stout as in species of the *pachymerus* group; legs with abundant bristly hairs; hind tibial comb with four ($n=9$) spines, the one nearest the spur longest.

Wing.—Pattern as figured; second radial cell blackish, very long, about three times as long as broad; three yellowish areas on anterior part of wing, a broad one at base of wing, one over r-m crossvein broadly to middle of cell M_2 , and a small narrow poststigmatic spot; wing otherwise uniformly grayish, darker along veins, sometimes with other very faint pale spots, one in distal part of anal cell, one in cell M_4 and one in cell M_2 behind medial fork. Macrotrichia entirely absent; costa extending to 0.64 (0.63–0.66, $n=9$) of distance to wing tip. Halter brownish.

Abdomen.—Dull blackish. Spermathecae two, pyriform, subequal, each measuring 0.053 by 0.031 mm., the bases of the ducts sclerotized a considerable distance.

MALE GENITALIA: Ninth sternum with a broad, shallow, caudo-median excavation; ninth tergum broad, with very small apicolateral processes. Basistyle with ventral root foot-shaped, the dorsal root slender; dististyle long and slender with bent, pointed tip. Aedeagus with narrow, pointed basal arch extending to two-thirds of total length, the basal arms stout and nearly straight; distal portion broad with a rounded median lobe and a pair of subapical points. Parameres each with large basal knob, stem bent slightly near base, straight and moderately stout on midportion, ventral lobe absent, tapering to flattened, laterally fringed, bladelike tip.

DISTRIBUTION: Guatemala; Mexico; Panama.

PANAMA RECORDS:

CANAL ZONE: Loma Boracho, Mojinga Swamp.

DISCUSSION: The relations of this species are obscure. In some respects it shows affinities with species of the *pachymerus* group and in others with *alahialinus* and *gorgasi* of the *furens* group, but more likely it is not closely related to any of these. Gibson and Ascoli (1952) found *stigmalis* to be a common man-biter in Guatemala.

Subgenus *Culicoides* (*Macfiella*) Fox

Macfiella Fox, 1955, Journ. Agr. Univ. Puerto Rico, vol. 39, p. 217. (Type: *Ceratopogon phlebotomus* Williston.)

Medium-sized species with the second radial cell very dark; wing with the pale spot present straddling middle of vein M_2 ; mesonotum

blue-green pruinose, with or without brown punctiform dots; eyes contiguous; fourth tarsal segment cordiform; antenna with sensoria present on segments III-X or on III, VI-X; palpal pit absent; six or seven tibial spines; two spermathecae; male genitalia with ventral root foot-shaped; parameres separate, basal knob simple, stem straight, with simple, bent distal point.

There are two species in this subgenus, both of which occur in Panama: *phlebotomus* (Williston) and *willistoni* Wirth and Blanton.

87. *Culicoides phlebotomus* (Williston)

FIGURE 90

Ceratopogon phlebotomus Williston, 1896, Trans. Ent. Soc. London, vol. 3, p. 281 (female; St. Vincent Island; fig. wing, palpus).

Culicoides phlebotomus, Kieffer, 1906, Genera Insectorum, fasc. 42, p. 55.—Hoffman, 1925, Amer. Journ. Hyg., vol. 5, p. 285 (female; Puerto Rico; fig. wing).—Painter, 1926, United Fruit Co. Med. Rep., vol. 15, p. 258 (Honduras, biology).—Fox, 1942, Puerto Rico Journ. Pub. Health Trop. Med., vol. 17, p. 419 (pupa; Virgin Islands; fig.).—Ortiz and Mirsa, 1952, Rev. Sanid. Asist. Soc., vol. 17, p. 275 (male, female; Venezuela; fig. spermathecae, antenna, palpus, tarsus, wing, male genitalia).—Wirth and Blanton, 1953, Ent. News, vol. 64, p. 114 (male, female; Puerto Rico, Mexico, Honduras, Nicaragua, Panama, Venezuela, Brazil; fig. wing, tarsus, male genitalia; synonym, *amazonius* Macfie).

Culicoides amazonius Macfie, 1935, Stylops, vol. 4, p. 52 (male, female; Tutoia, Brazil; fig. male genitalia).—Floch and Abonnenc, 1942, Inst. Pasteur Guyane Terr. l'Inini, publ. 37, p. 3 (French Guiana; fig. wing, palpus).

FEMALE: Length of wing 1.03 (0.89–1.15, $n=8$) mm.

Head.—Eyes contiguous a short distance, bare. Antenna with flagellar segments in proportion of 16:11:11:12:12:11:11:11:16:18:20:21:38, antennal ratio 1.19; distal sensory tufts present on segments III, and V or VI to X. Palpal segments in proportion of 13:24:26:10:13, third segment slightly swollen, 2.2 (1.8–2.5, $n=7$) times as long as greatest breadth, with a large, irregular, open sensory area. Mandible with 15 (13–17, $n=7$) teeth.

Thorax.—Mesonotum densely grayish, blue-green pollinose, without prominent pattern, sometimes with a pair of faint brownish longitudinal striae, with prominent blackish hairs. Scutellum, postscutellum and pleuron dark brown with dense grayish pollen. Legs yellowish brown, without distinctive bands; hind tibial comb with seven (6–8, $n=8$) spines, the one nearest the spur longest; fourth tarsal segments cordiform.

Wing.—Pattern as figured; color smoky brownish with distinct white spots; second radial cell blackish, the veins surrounding it very greatly thickened, the cell itself narrow; pale spot over r-m crossvein well developed; cell R, with four pale spots, three spots in a triangle in poststigmatic area, the distal spot large and usually broadly at-

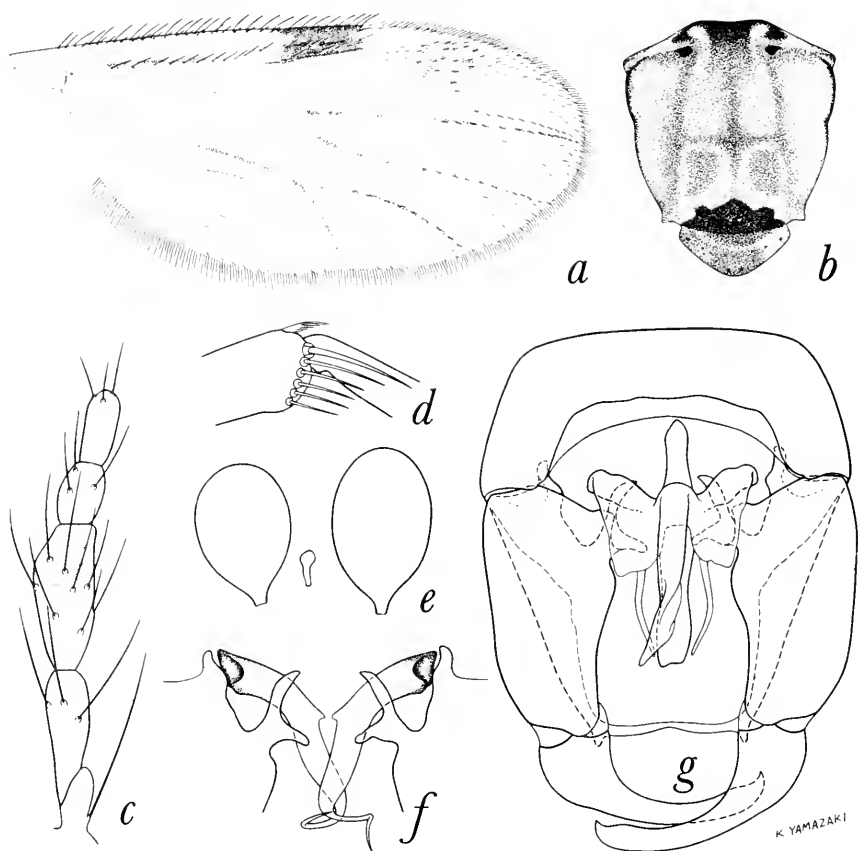


FIGURE 90.—*Culicoides phlebotomus* (Williston). *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f, g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

taining anterior wing margin; one pale spot in cell M_1 , located far from wing margin; pale spot present straddling middle of vein M_2 ; one pale spot in distal part of cell M_2 , located far from wing margin; small round pale spot present in center of cell M_4 ; anal cell with one pale spot in distal portion and a pale streak near base; cell M_2 with a pale spot lying behind medial fork and one lying in front of medio-cubital fork; a pale spot lying just distad of basal arculus and one lying over base of mediocubitus. Macrotrichia very sparse on distal fourth of wing; costa extending to 0.55 (0.53–0.58, $n=8$) of distance to wing tip. Halter pale.

Abdomen.—Brownish black. Spermathecae two, ovoid, unequal, measuring 0.058 by 0.043 mm. and 0.048 by 0.041 mm., the bases of the ducts not sclerotized.

MALE GENITALIA: Ninth sternum with a broad, rounded, caudo-median excavation; ninth tergum broad, short and tapering to very small apicolateral processes. Basistyle with ventral root foot-shaped but with very slender ankle and the heel developed nearly as long as the anterior toe, dorsal root slender; dististyle greatly curved from near base, with slender pointed tip. Aedeagus with a stout transverse bridge bearing a posteroventral, curved, pointed hook from the mid-portion; a long, nearly straight dorsal, rodlike sclerite passes the dorsal side of midportion of the basal bridge, the pointed anterior end extending well proximad of the bridge, the broad, rounded, flattened posterior end only slightly longer than the anterior hook. Parameres each with large, laterally directed, basal knob, the stem abruptly bent at base of the straight midportion, gradually tapered and distally curved ventrad in a filiform, simple tip.

DISTRIBUTION: St. Vincent; Brazil; Ecuador (Palmar, Guayas); French Guiana; Honduras; Mexico; Nicaragua; Panama; Puerto Rico; Trinidad; Venezuela; Virgin Islands.

PANAMA RECORDS:

CANAL ZONE: Fort Kobbe, Fort San Lorenzo, Loma Boracho, Mandinga River, Mindi Dairy, Mojinga Swamp.

COCLÉ PROVINCE: Puerto Farallón, Río Hato.

COLÓN PROVINCE: Chagres River, Piña, Puerto Farallón, Salud.

DARIÉN PROVINCE: Garachiné, Jaqué, Punta Patiño.

PANAMÁ PROVINCE: Arraiján, Camarón, Chame, Isla Taboga, San Carlos, Tocumen, Viqué Cove.

ARCHIPIÉLAGO DE LAS PERLAS: Isla del Rey.

DISCUSSION: The undotted mesonotum will readily separate this species from the closely related *willistoni* Wirth and Blanton.

88. *Culicoides willistoni* Wirth and Blanton

FIGURE 91

Culicoides willistoni Wirth and Blanton, 1953, Ent. News, vol. 64, p. 116 (male, female; Panama; fig. wing, palpus, male genitalia).

FEMALE: Length of wing 0.92 (0.86–0.99, $n=5$) mm.

Head.—Eyes contiguous, bare. Antenna with flagellar segments in proportion of 14:11:12:13:13:12:12:12:16:17:20:20:32, antennal ratio 1.06; distal sensory tufts present on segments III–X. Palpal segments in proportion of 10:21:31:10:12, third segment slightly swollen, 2.6 (2.2–2.8, $n=5$) times as long as greatest breadth, with sensoria scattered over mesal side of distal half of segment. Mandible with 14 (14–15, $n=5$) teeth.

Thorax.—Mesonotum densely bluish gray pruinose, with prominent pattern of scattered brown dots, each dot surrounding the base of one of the stout, brown, mesonotal hairs; the brown areas often

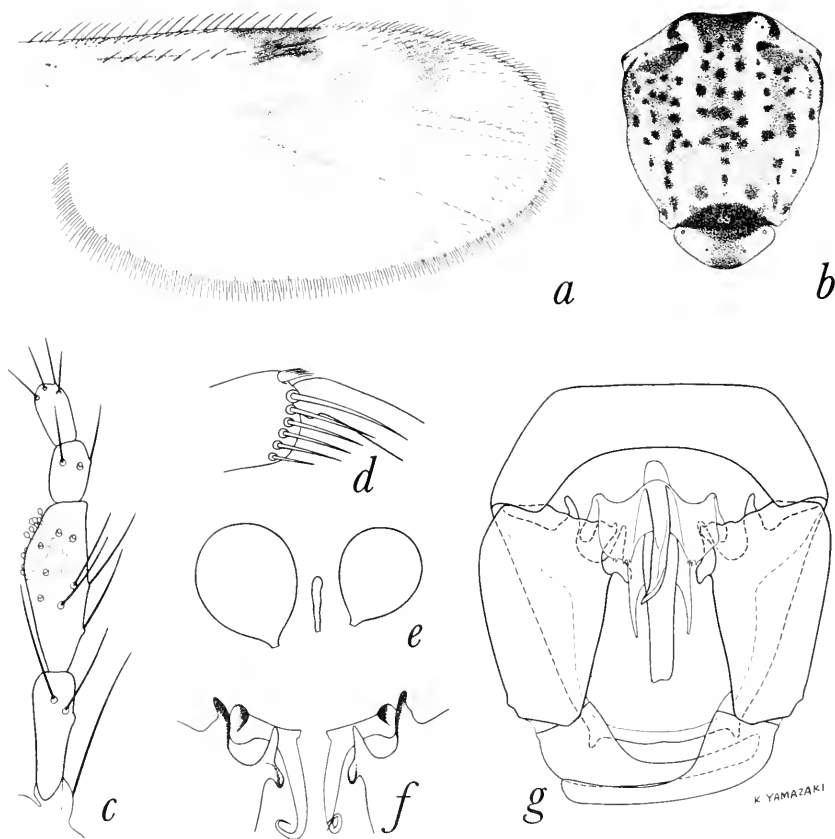


FIGURE 91.—*Culicoides willistoni* Wirth and Blanton. *a-e*, Female: *a*, wing; *b*, thoracic pattern; *c*, palpus; *d*, tibial comb; *e*, spermathecae. *f*, *g*, Male: *f*, parameres; *g*, genitalia, parameres removed.

confluent on middle of anterior margin and on sublateral areas between the suture and wing bases. Scutellum bluish gray pruinose, dark brown in middle; postscutellum and pleuron blackish with variable grayish pollinosity. Legs brown; bases of femora pale; femora with subapical, tibiae with subbasal and hind tibia with apical, narrow pale rings; hind tibial comb with six ($n=5$) spines, the one nearest the spur longest; fourth tarsal segments cordiform.

Wing.—Pattern as figured; grayish with distinctly white spots; second radial cell blackish, very narrow, the radial veins thickened; pale spot over r-m crossvein very large, extending into base of cell M_2 ; cell R_5 with four pale spots, the three poststigmatic spots small and round and situated in a triangle, distal spot large and irregular, and broadly meeting anterior wing margin, a blackish area located in

the dark area proximad of distal spot; branches of media and cubitus narrowly pale margined; pale spot present straddling middle of vein M_2 ; one pale spot, well separated from wing margin, in apex of each of cells M_1 , M_2 , M_4 and anal cell, the pale spot in anal cell elongate, another indistinct pale streak in basal portion of anal cell; cell M_2 with a pale spot lying behind medial fork, one lying in front of medio-cubital fork, and one lying across proximal part of cell and connected with the pale area at basal arculus. Macrotrichia confined to a few in apices of cells R_5 , M_1 and M_2 ; costa extending to 0.55 (0.53–0.56, $n=5$) of distance to wing tip. Halter whitish.

Abdomen.—Dark brown, narrow apices of terga with pale gray margins. Spermathecae two, pyriform, unequal, the larger measuring 0.053 by 0.036 mm., the bases of the ducts sclerotized a short distance.

MALE GENITALIA: Ninth sternum with shallow, rounded caudo-median excavation; ninth tergum tapered, with very short apicolateral processes. Basistyle with ventral root foot-shaped, the ankle slender, the heel and toe portions of subequal lengths, dorsal root slender; dististyle strongly bent basally, slender with pointed tip. Aedeagus with short, transverse basal arms, a short, stout, pointed median process projecting anteriorly from between them; posterior margins of basal arms with short, plate-like expansions; aedeagus bearing posteriorly a straight, spatulate, distally truncated, dorsal blade with a strong, ventrally curved process arising from the basal arms with its distally pointed tip curving towards the dorsal blade and about two-thirds as long. Parameres each with large, laterally directed, basal knob, stem moderately bent near base, a distinct, triangular projection on mesal side at the site of the bend, nearly straight in midportion, gradually narrowed distally to slender, filiform point.

DISTRIBUTION: Panama.

PANAMA RECORDS:

CHIRIQUI PROVINCE: Río Tabasará.

COCLE PROVINCE: Chirú, El Barrero, El Salado, La Venta, Puerto Farallón, Puerto Obaldía, Río Hato (type locality).

DARIÉN PROVINCE: Garachiné.

HERRERA PROVINCE: Puerto Chitré.

PANAMA PROVINCE: El Espino, Panamá Viejas, Puerto de Chorrera, Río Las Lajas, San Carlos, Tocumen, Viqué Cove.

ARCHIPIÉLAGO DE LAS PERLAS: Isla del Rey.

DISCUSSION: *C. willistoni* is confined to the Pacific coast beaches of Panama. It can readily be distinguished from the more widespread *phlebotomus* (Williston) by the mesonotal pattern of brown dots, pale-ringed legs, and more extensive pale wing spots including narrow pale margins to the veins.

ALPHABETICAL LIST OF SPECIES AND SYNONYMS

(Species number in parentheses, synonyms in italics)

acotylus (43)	fluvialis (60)	<i>painteri</i> (6)
<i>aethionotus</i> (41)	foxi (5)	<i>palpalis</i> (3)
alahialinus (56)	furens (59)	pampoikilus (24)
<i>alambicorum</i> (29)	gabaldoni (71)	panamensis (29)
almirantei (81)	galindoi (35)	<i>panamericanus</i> (43)
<i>amazonius</i> (87)	<i>gibsoni</i> (64)	paraensis (75)
antefurcatus (20)	ginesi (79)	patulipalpis (66)
arubae (85)	glabellus (70)	paucienfuscatus (49)
aureus (78)	glabrior (80)	phaenotus (25)
azureus (47)	<i>gorgasi</i> (58)	phlebotomus (87)
balsapambensis (63)	<i>grahambelli</i> (80)	<i>pictipennis</i> (45)
barbosai (57)	guyanensis (44)	pifanoi (50)
<i>beebei</i> (15)	heliconiae (1)	pilosus (28)
<i>bimaculatus</i> (4)	<i>hertigi</i> (30)	poikilonotus (30)
<i>cacozelus</i> (30)	hoffmani (73)	propiipennis (62)
camposi (38)	hylas (2)	<i>pseudodiabolicus</i> (4)
caprilesi (82)	imitator (74)	pusilloides (8)
carpenteri (39)	<i>inamollae</i> (6)	pusillus (9)
carsiomelas (42)	insignis (6)	rangeli (67)
castillae (64)	iriartei (33)	<i>recifensis</i> (44)
chrysonotus (19)	jamaicensis (31)	reticulatus (54)
commatis (23)	<i>kintzi</i> (82)	rostratus (13)
<i>contubernalis</i> (3)	lanei (46)	<i>rozeboomi</i> (1)
covagarciai (15)	leopoldoi (65)	scopus (34)
crescentis (21)	limai (36)	spurius (72)
daedaloides (27)	lutealaris (18)	stigmalis (86)
daedalus (22)	luteovenus (11)	<i>stubalensis</i> (44)
debilipalpis (76)	lyrinotatus (53)	tenuilobus (37)
diabolicus (4)	macrostigma (55)	tetrathyrus (61)
dicrourus (51)	<i>maculithorax</i> (59)	transferrans (68)
<i>diminutus</i> (7)	magnipalpis (40)	<i>tricoloratus</i> (50)
<i>dovei</i> (59)	marshi (14)	trinidadensis (7)
dunni (26)	metagonatus (16)	<i>undecimpunctatus</i> (75)
efferus (12)	mirsaе (77)	uniradialis (84)
elutus (10)	<i>miyamotoi</i> (78)	<i>vargasi</i> (33)
evansi (32)	mojingaensis (48)	venezuelensis (45)
<i>fairchildi</i> (38)	nigri-genus (17)	verecundus (3)
fieldi (69)	<i>ocumarensis</i> (4)	volcanensis (52)
<i>filariferus</i> (4)	<i>ortizi</i> (45)	willistoni (88)
<i>flochabonnenci</i> (64)	pachymerus (83)	wokei (41)

References

- ADAMSON, A. M.
1939. Observations on biting sandflies (Ceratopogonidae) in Trinidad, B. W. I. Trop. Agr., vol. 16, pp. 79-81.
- ARNETT, R. H., JR.
1950. Notes on the distribution, habits, and habitats of some Panama culicines (Diptera: Culicidae). Pt. 4. Ecology. Journ. New York Ent. Soc., vol. 58, pp. 99-115.
- BARBOSA, F. A. S.
1943. Descrição de "*Culicoides recifensis*" n. sp. e do macho de "*Culicoides reticulatus*" Lutz (Diptera, Chironomidae). Rev. Brasil. Biol., vol. 3, pp. 261-264.
1944. "*Culicoides insignis*" Lutz, com a descrição do Hipopigio (Diptera, Chironomidae). Rev. Brasil. Biol., vol. 4, pp. 259-261.
1947. *Culicoides* (Diptera: Heleidae) da Região Neotrópica. Anais Soc. Biol. Pernambuco (Brazil), vol. 7, pp. 3-30, pl.
1951. A change of specific name in the genus *Culicoides* (Diptera, Heleidae). Proc. Ent. Soc. Washington, vol. 53, p. 163.
1952. Novos subsidios para o conhecimento dos *Culicoides* Neotrópicos (Diptera: Heleidae). Imprensa Industrial, Recife. 21 pp., 10 pl.
- BARRETTO, M. P.
1944. Sôbre o gênero "*Culicoides*" Latreille, 1809, com a descrição de três espécies (Diptera, Ceratopogonidae). Anais Fac. Med. Univ. São Paulo, vol. 20, pp. 89-105, 4 pls.
- BLANTON, F. S.; GALINDO, P.; AND PEYTON, E. L.
1955. Report of a three-year light trap survey for biting Diptera in Panama. Mosquito News, vol. 15, pp. 90-93.
- BLANTON, F. S.; GRAHAM, O. H.; AND KEENAN, C. M.
1955. Notes on *Culicoides furens* (Poey) at Fort Kobbe, Canal Zone. Mosquito News, vol. 15, pp. 13-18.
- BUCKLEY, J. C. C.
1934. On the development in *Culicoides furens* Poey, of *Filaria* (*Mansonnella*) ozzardi Manson, 1897. Journ. Helminth., vol. 12, pp. 99-118.
1938. On *Culicoides* as a vector of *Onchocerca gibsoni* (Cleland and Johnston, 1910). Journ. Helminth., vol. 16, pp. 121-158.
- CARPENTER, S. J.
1951. Studies of *Culicoides* in the Panama Canal Zone (Diptera, Heleidae). Mosquito News, vol. 11, pp. 202-208.
- CARTER, H. F.; INGRAM, A.; AND MACFIE, J. W. S.
1920. Observations on the Ceratopogonine midges of the Gold Coast with descriptions of new species. I-II. Ann. Trop. Med. Parasit., vol. 14, pp. 187-274, 5 pls.
- CAUSEY, O. R.
1938. *Culicoides* of Siam with descriptions of new species. Amer. Journ. Hyg., vol. 27, pp. 399-416, 8 pls.
- CHAPMAN, F. M.
1917. The distribution of bird life in Colombia. Bull. Amer. Mus. Nat. Hist., vol. 36, pp. 1-729, 41 pls.

CHARDROME, M., AND PEEL, E.

1951. Recherches sur la répartition des filaires dans la région de Coquilhatville et la transmission de *Dipetalonema streptocerca* par *Culicoides grahami* Austen. Mem. Inst. Roy. Colon. Belge Sect. Sci. Nat. Med., vol. 19, pp. 3-83.

COSTA LIMA, A. DA

1937. Chave das especies de *Culicoides* da região neotropica (Diptera : Ceratopogonidae). Mem. Inst. Oswaldo Cruz, vol. 32, pp. 411-422.

DAMPF, A.

1936. Los Ceratopogónidos o jejenes (Insecta, Diptera: fam. Ceratopogonidae), como transmisores de filarias. Med. Rev. Mexicana, vol. 16, no. 268 (May 25), pp. 227-233.

DOVE, W. E.; HALL, D. G.; AND HULL, J. B.

1932. The salt marsh sand fly problem. Ann. Ent. Soc. Amer., vol. 25, pp. 505-527.

DUNN, L. H.

1934. Entomological investigations in the Chiriqui Region of Panama. Psyche, vol. 41, pp. 166-183.

EDWARDS, F. W.

1922. On some Malayan and other species of *Culicoides*, with a note on the genus *Lasiohelea*. Bull. Ent. Res., vol. 13, pp. 161-167, 1 pl.

EDWARDS, F. W.

1939. In Edwards, Oldroyd, and Smart. British blood-sucking flies. London, British Museum. 156 pp., 45 pl.

FAIRCHILD, G. B.

1943. An annotated list of the bloodsucking insects, ticks and mites known from Panama. Amer. Journ. Trop. Med., vol. 23, pp. 569-591.

FIEDLER, O. G. H.

1951. The South African biting midges of the genus *Culicoides* (Ceratopogonid., Dipt.). Onderstepoort Journ. Vet. Res., vol. 25, pp. 1-33.

FLOCH, H., AND ABONNENC, E.

1942. Cératopogonidés hématophages de la Guyane Française. Inst. Pasteur Guayane Terr. l'Inini, publ. no. 37, 10 pp.

FOOTE, R. H., AND PRATT, H. D.

1954. The *Culicoides* of the eastern United States (Diptera, Heleidae). Publ. Health Monogr. No. 18, 55 pp.

FORATTINI, O. P.

1953. *Culicoides trinidadensis* Hoffman 1925 (Diptera, Ceratopogonidae). Arq. Fac. Hig. Saude Pub. Univ. São Paulo, vol. 7, pp. 123-126.

FORATTINI, O. P., AND GALVÃO, A. B.

1955. Rédescrição de *Culicoides maruim* Lutz, 1913 e *C. reticulatus* Lutz, 1913 (Diptera, Ceratopogonidae). Rev. Brasileira Mal., vol. 7, pp. 225-233.

FOX, I.

1942. The respiratory trumpet and anal segment of the pupae of some species of *Culicoides* (Diptera : Ceratopogonidae). Puerto Rico Journ. Publ. Health Trop. Med., vol. 17, pp. 412-425.

1946. A review of the species of biting midges or *Culicoides* from the Caribbean Region (Diptera : Ceratopogonidae). Ann. Ent. Soc. Amer., vol. 39, pp. 248-258.

1947. Two new Central American biting midges or *Culicoides* (Diptera : Ceratopogonidae). Kuba, vol. 3, pp. 90-91.

1948. *Hoffmania*, a new subgenus in *Culicoides* (Diptera : Ceratopogonidae). Proc. Biol. Soc. Washington, vol. 61, pp. 21-28.
1949. Notes on Puerto Rican biting midges or *Culicoides* (Diptera: Ceratopogonidae). Bull. Brooklyn Ent. Soc., vol. 44, pp. 29-34.
- 1952a. Light trap studies on *Culicoides* in Puerto Rico. Journ. Econ. Ent., vol. 45, pp. 888-889.
- 1952b. Six new Neotropical species of *Culicoides*. Ann. Ent. Soc. Amer., vol. 45, pp. 364-368.
- 1955a. A catalogue of the bloodsucking midges of the Americas (*Culicoides*, *Leptoconops* and *Lasiohelea*) with keys to the subgenera and Nearctic species, a geographic index and bibliography. Journ. Agr. Univ. Puerto Rico, vol. 39, No. 4, pp. 214-285.
- 1955b. Nuevos aelantos en el estudio del genero *Culicoides*. Bol. Lab. Clin. Luis Razetti 1955, pp. 635-639.
- FOX, I., AND HOFFMAN, W. A.
1944. New Neotropical biting sandflies of the genus *Culicoides* (Diptera : Ceratopogonidae). Puerto Rico Journ. Publ. Health Trop. Med., vol. 20, pp. 108-111.
- GAD, A. M.
1951. The head-capsule and mouth-parts in the Ceratopogonidae (Diptera-Nematocera). Bull. Soc. Fouad 1er d'Ent., vol. 44, pp. 17-75.
- GIBSON, C. L., AND ASCOLI, W. F.
1952. The relation of *Culicoides* (Diptera : Heleidae) to the transmission of *Onchocerca volvulus*. Journ. Parasit., vol. 38, pp. 315-320.
- GOLDMAN, E. A.
1920. Mammals of Panama. Smithsonian Misc. Coll., vol. 69, no. 5, pp. 1-309, 1 map, 39 pl.
- GRISCOM, L.
1935. The ornithology of the Republic of Panama. Bull. Mus. Comp. Zool., vol. 78, pp. 259-382.
1940. Origin and relationships of the faunal areas of Central America. Proc. Eighth Amer. Sci. Congress, vol. 3, pp. 424-430.
1950. Distribution and origin of the birds of Mexico. Bull. Mus. Comp. Zool., vol. 103, pp. 341-382.
- GUTSEVITCH, A. V.
1952. Contribution to the fauna of sandflies of the genus *Culicoides* of the forest zone (Diptera, Heleidae). Parasit. Symp. Zool. Inst. Parasit. Sec., vol. 14, pp. 75-94. [In Russian.]
- HALL, D. G.
1932. A new biting *Culicoides* from saltmarshes in the Southeastern States. Proc. Ent. Soc. Washington, vol. 34, pp. 88-89.
- HENRARD, C., AND PEEL, E.
1949. *Culicoides grahami* Austen. Vecteur de *Dipetalonema streptocerca* et non de *Acanthocheilonema perstans*. Ann. Soc. Belge Méd. Trop., vol. 29, pp. 127-143.
- HILL, M. A.
1947. The life-cycle and habits of *Culicoides impunctatus* Goetghebuer and *Culicoides obsoletus* Meigen, together with some observations on the life-cycle of *Culicoides odibilis* Austen, *Culicoides pallidicornis* Kieffer, *Culicoides cubitalis* Edwards and *Culicoides chiopterus* Meigen. Ann. Trop. Med. Parasit., vol. 41, pp. 55-115.

- HOFFMAN, W. A.
1925. A review of the species of *Culicoides* of North and Central America and the West Indies. Amer. Journ. Hyg., vol. 5, pp. 274-301.
1939. *Culicoides filariferus*, new species. Intermediate host of an unidentified filaria from southwestern Mexico. Puerto Rico Journ. Publ. Health Trop. Med., vol. 15, pp. 172-174.
- HOPKINS, C. A.
1952. Notes on the biology of certain *Culicoides* studied in the British Cameroons, West Africa, together with observations on their possible role as vectors of *Acanthocheilonema perstans*. Ann. Trop. Med. Parasit., vol. 46, pp. 165-172.
- HOPKINS, C. A., AND NICHOLAS, W. L.
1952. *Culicoides austeni*, the vector of *Acanthocheilonema perstans*. Ann. Trop. Med. Parasit., vol. 46, pp. 276-283.
- JOBLING, B.
1928. The structure of the head and mouth-parts in *Culicoides pulicaris* L. (Diptera, Nematocera). Bull. Ent. Res., vol. 18, pp. 211-236.
- KENOYER, L. A.
1929. General and successional ecology of the lower tropical rain-forest at Barro Colorado Island, Panama. Ecology, vol. 10, pp. 201-222.
- KETTLE, D. S., AND LAWSON, J. W. H.
1952. The early stages of British biting midges *Culicoides* Latreille (Diptera: Ceratopogonidae) and allied genera. Bull. Ent. Res., vol. 43, pp. 421-467, 6 pls.
- KHALAF, K.
1954. The speciation of the genus *Culicoides* (Diptera, Heleidae). Ann. Ent. Soc. Amer., vol. 47, pp. 34-51.
- LANE, J., AND ORTIZ, I.
1950. Sinonimia en *Culicoides* (Diptera, Ceratopogonidae). Rev. Sanid. Asist. Soc., vol. 15, p. 460.
- LAWSON, J. W. H.
1951. The anatomy and morphology of the early stages of *Culicoides nubeculosus* Meigen (Diptera, Ceratopogonidae=Heleidae). Trans. Roy. Ent. Soc. London, vol. 102, No. 9, pp. 511-570, 1 pl.
- LEE, D. J.
1948. Australasian Ceratopogonidae (Diptera, Nematocera). Pt. 1. Relation to disease, biology, general characters and generic classification of the family, with a note on the genus *Ceratopogon*. Proc. Linn. Soc. New South Wales, vol. 72, pp. 313-331.
- LEE, D. J., AND REYE, E. J.
1953. Australasian Ceratopogonidae (Diptera, Nematocera). Pt. 6. Australian species of *Culicoides*. Proc. Linn. Soc. New South Wales, vol. 77, pp. 369-394. 1 pl.
- LUTZ, A.
1913. Contribuição para o estudo das "Ceratopogoninas" hematofagas do Brasil (parte sistemática). Mem. Inst. Oswaldo Cruz, vol. 5, pp. 45-73, 3 pl.
1914. Contribuição para o conhecimento das "Ceratopogoninas" do Brasil (Aditamento terceiro e descrição de espécies que não sugam sangue). Mem. Inst. Oswaldo Cruz, vol. 6, pp. 81-99, 2 pls.
- MACFIE, J. W. S.
1937. Ceratopogonidae from Trinidad. Ann. Mag. Nat. Hist., ser. 10, vol. 20, pp. 1-18.

1940. A report on a collection of Ceratopogonidae (Diptera) from British Guiana. Ent. Monthly Mag., vol. 76, pp. 25-32.
1948. Some species of *Culicoides* (Diptera, Ceratopogonidae) from the State of Chiapas, Mexico. Ann. Trop. Parasit., vol. 42, pp. 67-87.
- MIRSA, A., MIRSA, M., AND ORTIZ, I.
1952. Primer hallazgo de formas evolutivas de microfilarias en el tórax de *Culicoides* (*C. pifanoi* Ortiz, 1951) en Venezuela. Rev. Sanid. Asist. Soc., vol. 17, pp. 159-162.
- MIRSA, M., AND ORTIZ, I.
1952. Estudios en *Culicoides* (Diptera, Ceratopogonidae) 10. Sobre la hembra de *Culicoides dominicii* Ortiz, 1951. Bol. Lab. Clín. "Luis Razetti," vol. 16, pp. 475-478.
- MYERS, J. G.
1935. The sand-fly pest (*Culicoides*). Trop. Agr., vol. 12, pp. 71-73.
- ORTIZ, I.
1949. Nota sobre nuevos Ceratopogonidos hematófagos para Venezuela. Bol. Lab. Clín. "Luis Razetti," vol. 15, pp. 326-329.
- 1950a. Estudios en *Culicoides*. II. Diptera, Ceratopogonidae *Culicoides lanei* n. sp. de Panama. Rev. Sanid. Asist. Soc. vol. 15, pp. 431-433.
- 1950b. Estudios en *Culicoides*. IV. Revisión de las especies americanas del sub-genero *Hoffmania* Fox 1948, con la descripción de los nuevos especies. Rev. Sanid. Asist. Soc., vol. 15, pp. 437-460.
- 1950c. Estudios en *Culicoides*. V. Informes sobre una nueva especie y lista de los machos cuyas genitalias son conocidad. Rev. Sanid. Asist. Soc., vol. 15, pp. 461-465.
- 1951a. Estudios en *Culicoides* (Diptera, Ceratopogonidae). VI. *Culicoides briceñoi* n. sp. Bol. Lab. Clín. "Luis Razetti," vol. 16, pp. 442-448.
- 1951b. Estudios sobre *Culicoides* (Diptera, Ceratopogonidae). VII. *Culicoides dominicii* n. sp. y clave para el reconocimiento de las especies venezolanas. Nov. Cient. Contr. Ocas. Mus. Hist. Nat. La Salle, zool. ser., no. 5, 12 pp.
- 1951c. Estudios en *Culicoides* (Diptera, Ceratopogonidae). IX. Sobre los caracteres diferenciales entre *Culicoides paraensis* (Goeldi, 1905), *C. stellifer* (Coquillett, 1901) y *C. lanei* (Ortiz, 1950). Descripción de cuatro nuevas especies con la redescipción de algunas otras poco conocidas. Rev. Sanid. Asist. Soc., vol. 16, pp. 573-591.
1952. Nota sobre la presencia de "*Culicoides eublepharus*" Macfie, 1948 (Diptera, Ceratopogonidae) en Venezuela—descripción la armadura genital del macho. Acta Cient. Venezolana, vol. 3, p. 129.
- 1953a. Nueva contribución al conocimiento de los caracteres morfológicos externos de las hembras Americanas del género *Culicoides* Ltr. (Diptera, Ceratopogonidae) con una espermateca. Rev. Sanid. Asist. Soc., vol. 18, pp. 797-806.
- 1953b. Sobre una nueva especie del género *Culicoides* (Diptera, Ceratopogonidae) próxima de *C. horticola* Lutz 1913. Rev. Sanid. Asist. Soc., vol. 18, pp. 807-812.
1954. Sobre dos nuevos dípteros hematofagos del genero *Culicoides* (Nematocera, Ceratopogonidae). Arch. Venezolana Patol. Trop. Parasit. Méd., vol. 2, pp. 221-226.
- ORTIZ I., AND LEON, L. A.
1954. Los *Culicoides* (Diptera : Ceratopogonidae) de la República del Ecuador. Bol. Inf. Cient. Nac., vol. 7, pp. 564-590.

ORTIZ, I., AND MIRSA, M.

1950. Estudios en *Culicoides* (Diptera, Ceratopogonidae). VIII. Sobre una nueva especie del grupo haematopodus: *Culicoides venezuelensis* n. sp. Arch. Venezolana Patol. Trop. Parasit. Med., vol. 2, pp. 137-144, 1 pl.
1951. Estudios en *Culicoides* (Díptera, Ceratopogonidae). Descripción de dos nuevas especies: *Culicoides avilaensis* y *C. discrepans*, y del macho de *C. leopoldoi* Ortiz, 1951. Redescrípción de *C. limai* Barretto, 1944, *C. baueri* Hoffman, 1925, *C. lichyi* Floch & Abonnenc, 1949 y *C. pusillus* Lutz, 1913. Rev. Sanid. Asist. Soc., vol. 16, pp. 593-605.
- 1952a. *Culicoides* de Venezuela. Redescrípción de 10 especies con la descripción de algunos sexos no conocidos. Rev. Sanid. Asist. Soc., vol. 17, pp. 257-279.
- 1952b. Sobre las especies Americanas del género "*Culicoides*" Latr. (Diptera, "Ceratopogonidae") con una espermateca. Acta Cient. Venezolana, vol. 3, pp. 125-128.

PAINTER, R. H.

1926. The biology, immature stages, and control of the sandflies (biting Ceratopogoninae) at Puerto Castilla, Honduras. Ann. Rep. Med. Dep. United Fruit Co. 1926, pp. 245-262, 1 pl.

PICADO, C.

1913. Les broméliacées épiphytes considérées comme milieu biologique. Bull. Sci. France Belgique, vol. 47, pp. 215-360, 19 pls.

POSNETTE, A. F.

1944. Pollination of cacao in Trinidad. Trop. Agr., vol. 21, pp. 115-118.

PRICE, D. A., AND HARDY, W. T.

1954. Isolation of the bluetongue virus from Texas sheep—*Culicoides* shown to be a vector. Journ. Amer. Vet. Med. Assoc., vol. 124, pp. 255-261.

ROOT, F. M., AND HOFFMAN, W. A.

1937. The North American species of *Culicoides*. Amer. Journ. Hyg., vol. 25, pp. 150-176, 8 pls.

RYCKMAN, R. E., AND AMES, C. T.

1953. Insects reared from cacti in Arizona. Pan-Pac. Ent., vol. 29, pp. 163-164.

SCHUCHERT, C.

1935. Historical geology of the Antillean-Caribbean region. 811 pp.

STANDLEY, P. C.

1928. Flora of the Panama Canal Zone. Contr. U. S. Nat. Herbarium, vol. 27, pp. 1-416.

STEWART, J. S.

1933. *Onchocerca cervicalis* (Railliet and Henry, 1910) and its development in *Culicoides nubeculosus* Mg. Rep. Inst. Anim. Path., Cambridge Univ., vol. 3, pp. 272-284.

TOIT, R. M. DU

1944. The transmission of blue-tongue and horse-sickness by *Culicoides*. Onderstepoort Journ. Vet. Res., vol. 19, pp. 7-16.

TOKUNAGA, M.

1937. Sand flies (Ceratopogonidae, Diptera) from Japan. Tenthredo, vol. 1, pp. 233-338.

VARGAS, L.

- 1944. *Culicoides diabolicus* en Mexico. Caractres del macho. Rev. Inst. Salub. Enf. Trop., vol. 5, pp. 163-169.
- 1945. Nota sobre Ceratopogónidos y *Culicoides*. Rev. Inst. Salub. Enf. Trop., vol. 6, pp. 41-49.
- 1949. Lista de los *Culicoides* del mundo (Diptera, Heleidae). Rev. Soc. Mexicana Hist. Nat., vol. 10, pp. 191-218.
- 1953a. *Beltranmyia* n. subg. de *Culicoides* (Insecta: Heleidae). Rev. Inst. Salub. Enf. Trop., vol. 13, pp. 33-36.
- 1953b. *Culicoides wirthomyia* n. sp. y *Culicoides stigmalis* Wirth 1952. Rev. Inst. Salub. Enf. Trop., vol. 13, pp. 227-233.
- 1954. Dos nuevas especies de *Culicoides* Mexicanos. Rev. Inst. Salub. Enf. Trop., vol. 14, pp. 25-32.

VARGAS, L., AND WIRTH, W. W.

- 1955. *Culicoides blantoni* n. sp. (Dipt., Heleidae). Rev. Inst. Salub. Enf. Trop., vol. 15, pp. 33-35.

WARMKE, H. E.

- 1951. Studies on pollination of *Hevea brasiliensis* in Puerto Rico. Science, vol. 113, pp. 646-648.
- 1952. Studies on natural pollination of *Hevea brasiliensis* in Brazil. Science, vol. 116, pp. 474-475.

WILLIAMS, R. W.

- 1951. Observations on the bionomics of *Culicoides tristriatulus* Hoffman with notes on *C. alaskensis* Wirth and other species at Valdez, Alaska, summer 1949. Ann. Ent. Soc. Amer., vol. 44, pp. 173-183.
- 1955a. Studies on the *Culicoides* of Baker County, Georgia (Diptera, Heleidae). I. Preliminary survey and observations. Ann. Ent. Soc. Amer., vol. 48, pp. 30-34.
- 1955b. Observations on the bionomics of some *Culicoides* of Cheboygan County, Michigan (Diptera, Heleidae). Bull. Brooklyn Ent. Soc., vol. 50, pp. 113-120.

WIRTH, W. W.

- 1952a. The Heleidae of California. Univ. California Publ. Ent., vol. 9, pp. 95-266.
- 1952b. Two new species of anthropophilic *Culicoides* from Guatemala (Diptera: Heleidae). Journ. Parasit., vol. 38, pp. 245-247.
- 1955a. The biting midge genera *Psychophaena* and *Tetrastophora* of Philippi 1865. Rev. Chilena Ent., vol. 4, pp. 233-235.
- 1955b. Report on a collection of biting midges of the genus *Culicoides* from Guatemala. (Diptera, Heleidae). Proc. Ent. Soc. Washington, vol. 57, pp. 109-117.
- 1956. The heleid midges (Diptera, Heleidae) involved in the pollination of rubber trees in America. Proc. Ent. Soc. Washington, vol. 58, pp. 241-250.

WIRTH, W. W., AND BLANTON, F. S.

- 1953a. Studies in Panama *Culicoides* (Diptera: Heleidae) I. Descriptions of six new species. Journ. Washington Acad. Sci., vol. 43, pp. 69-77.
- 1953b. Studies in Panama *Culicoides* (Diptera, Heleidae) II. Descriptions of six additional new species. Journ. Parasit., vol. 39, pp. 229-236.
- 1953c. Studies in Panama *Culicoides* (Diptera, Heleidae) III. A new species related to *phlebotomus* (Williston). Ent. News, vol. 64, pp. 113-120.

- 1955a. Studies in Panama *Culicoides* (Diptera, Heleidae) IV. Description of three new species. Bull. Brooklyn Ent. Soc., vol. 50, pp. 100-106.
- 1955b. Studies in Panama *Culicoides* (Diptera, Heleidae) V. Descriptions of three new species of the subgenus *Oecacta* Poey. Bull. Brooklyn Ent. Soc., vol. 50, pp. 121-127.
- 1956a. Studies in Panama *Culicoides* (Diptera, Heleidae) VI. The *hylas* group of the subgenus *Hoffmania*. Journ. Washington Acad. Sci., vol. 46, pp. 95-99.
- 1956b. Studies in Panama *Culicoides* (Diptera, Heleidae) VII. The species of the *pulicaris* and *covagarciai* Groups. Proc. Ent. Soc. Washington, vol. 58, pp. 211-227.
- 1956c. Studies in Panama *Culicoides* VIII. The Neotropical species of the *guttatus* group of the subgenus *Hoffmania* (Diptera, Heleidae). Proc. Ent. Soc. Washington, vol. 58, pp. 305-326.
- 1956d. Studies in Panama *Culicoides* (Diptera, Heleidae) IX. Two new species related to *leoni* Barbosa and *reevesi* Wirth. Bull. Brooklyn Ent. Soc., vol. 51, pp. 45-52.
- 1956e. Redescriptions of four new species of Neotropical *Culicoides* of the *debilipalpis* group (Diptera, Heleidae). Journ. Washington Acad. Sci., vol. 46, pp. 186-190.
- 1956f. A new species of salt marsh sandfly from Florida, the Bahamas, Panama and Ecuador, its distribution and taxonomic differentiation from *Culicoides furens* (Poey) (Diptera, Heleidae). Florida Ent., vol. 39, pp. 157-162.

Woke, P. A.

1954. Observations on Central American biting midges (Diptera, Heleidae). Ann. Ent. Soc. Amer., vol. 47, pp. 61-74.



INDEX

(New genera, species, etc., are printed in *italics*. Page numbers of principal entries also in *italics*)

- abbreviata*, *Mya truncata*, 184
acotylus, *Culicoides*, 244, 245, 261, 269, 314, 363, 367, 368 (fig.)
Acteocinidae, 70, 138
adamsi, *Thracia*, 71, 163
Admete, 129
 couthouyi, 66, 69, 129, 130, 131
 couthouyi laevior, 129
 crispa, 129
 middendorffiana, 129, 130, 131
 regina, 69, 131
 subg., 130
Aeolidiacea, 144
Aeolis papillosa, 145
aethionotus, *Culicoides*, 363, 365
affinis, *Calisius*, 214, 216, 217
Agrilus anxius, 231
Agromyzidae, 223, 224
alahialinus, *Culicoides*, 245, 261, 265, 398, 399 (fig.), 402, 404, 468
alaskana, *Alvania castanea*, 84
 Cingula castanea, 84
 Venericardia, 169
alba, *Lepeta*, 73, 74
albus, *Chiton*, 145
 Trachydermon, 70, 145
Aleyonidium polyoum, 87
Aldisa, 143
 zetlandica, 70, 143
aleutica, *Diplodonta*, 71, 172
almirantei, *Culicoides*, 245, 262, 271, 454, 455 (fig.), 459
alta, *Trichotropis bicarinata*, 88
Alvania, 85
 castanea alaskana, 84
 jan-mayeni, 68, 85
amazonius, *Culicoides*, 469
Amicula vestita, 147
amoena, *Raphitoma*, 67, 69, 187
amoenus, *Gonatus*, 148
Amphineura, 70, 145
Amphisphyra expansa, 139
 globosa, 139
Amphitrite frondosa, 144
ampla, *Panomya*, 71, 189, 190
 Panope, 189
ampliceps, *Calisiopsis*, 212, 213 (fig.), 220, 221, 222
Aneurinae, 209
Anfractogon, 1, 3, 4, 7, 8, 20, 49
 tenebrans, 2, 3, 7, 8, 48
 angulosum, *Buccinum*, 66, 67, 69, 103, 109, 110, 111, 112, 114
aniwana, *Lioecyma*, 177, 178, 179
annulicornis, *Calisius*, 209, 219
Anomalodesmacea, 71, 162
antefurcatus, *Culicoides*, 244, 260, 268 314, 315 (fig.), 317, 319, 321, 356
antiquum, *Tritonium*, 122, 123
anxius, *Agrilus*, 231
Apheloria, 4, 52
Aquilonaria, 83
 turneri, 68, 83, 84
arachnoides, *Cecropia*, 243
Aradacanthia, 210, 211, 213 (figs.)
 multicalcarata, 209, 210, 212, 213 (fig.)
Aradidae, 209, 211, 220
 Notes on, in the U.S. National Museum, 209
Aradinae, 209
Aradoidea, 209
Aradosyrtis, 211
arborescens, *Dendronotus*, 144
 Doris, 144
Arca minuta, 150
 tenuis, 149
arctica, *Astarte*, 165
 Glycineris, 189
 Hiatella, 71, 156, 160, 167, 190
 Leda, 151
 Nucula, 151
 Nuculana, 67, 70
 Panomya, 71, 189, 190
 Panopaea, 189
 Portlandia, 151
 Saxicava, 190
 Yoldia, 151
Arcytophyllum lavarum, 244
arenaria, *Mya*, 185, 186, 187, 188
armata, *Poulsenia*, 243
arubae, *Culicoides*, 245, 246, 248, 249, 262, 265, 314, 464, 465 (fig.)
Aspidobranchia, 68, 73
Astarte, 65, 71, 164
 arctica, 165
 banksii, 167
 borealis, 71, 165, 168, 178, 191
 crassidens, 170
 fabula, 167
 globosa, 167
 montagui, 71, 167, 178

- Astarte*, *montagui* *fabula*, 168
montagui *globosa*, 167, 168
montagui *striata*, 167, 168
montagui *warhami*, 167, 168
pulehella, 167
richardsoni, 165
semisulcata, 165
striata, 167
warhami, 167
Astartidae, 71, 164
Asthenodonta, 184
aureus, *Culicoides*, 244, 262, 272, 431, 447, 448 (fig.), 451
australis, *Calisius*, 212, 213 (fig.), 218, 219, 220
Avaritia, subg., 258, 259, 290
avenosooki, *Margarites*, 68, 77
avilensis, *Culicoides*, 388, 389, 390
Axinopsida, 172
orbiculata, 71, 172
orbiculata *inaequalis*, 172
viridis, 172
Axinopsis *orbiculata*, 172
Axinus *flexuosus*, 171
gouldii, 171
sarsii, 171
azureus, *Culicoides*, 245, 261, 271, 377 (fig.), 384, 395

bakeri, *Culicoides*, 341, 342
balsapambensis, *Culicoides*, 244, 261, 272, 273, 407, 414 (fig.)
bamffinus, *Trophon*, 97
banksii, *Astarte*, 167
Nicania, 167
balthica, *Macoma*, 182
barbosai, *Culicoides*, 245, 249, 261, 272, 398, 399, 400 (fig.), 404
Barentsia *gorbunovi*, 160
sp., 156
baueri, *Culicoides*, 346
beckii, *Liocyma*, 177, 178, 179
beebei, *Culicoides*, 304
behringi, *Beringius*, 116
behringiana, *Tritonium antiquum*, 123
behringii, *Tritonium*, 117, 118
Bela, 132
elegans, 135
harpa, 134
harpularia, 135
impressa, 137
laevigata, 133
pyramidalis, 136
pyramidalis *semiplicata*, 136
simplex, 133
tenuicostata, 134
tenuilirata, 132
Beltranmyia, subg., 258
benarrochei, *Culicoides*, 428
benderi, *Brachoria*, 2, 11, 14, 15
Benthoctopus, 67, 70, 149
hokkaidensis, 70, 149
beringensis, *Rochefortia*, 175
beringi, *Beringius*, 69, 117, 118, 119
Boreotrophon, 69, 99, 100
Trophon, 99
Volutopsius, 117, 119

beringii, *Tritonium*, 118
Beringius, 65, 115
beringi, 69, 116, 117, 118, 119
beringi *kobelti*, 69, 117, 118, 119
malleatus, 115, 116
stimpsoni, 66, 69, 115
stimpsoni *malleatus*, 115, 116, 117
stimpsoni *stimpsoni*, 117
Betula *papyrifera*, 231
sp., 231
betulae, *Odinia*, 224, 226, 230
bicarinata, *Trichotropis*, 68, 88
bicarinatus, *Turbo*, 88
biguttata, *Odinia*, 225, 226, 228, 230, 231, 233, 236
bilobatus, *Calisius*, 212, 213 (fig.), 214
bimaculatus, *Culicoides*, 280
Biting midges of the genus *Culicoides* from Panama (Diptera: Heleidae), 237
Blanton, *Franklin S.*, see *Wirth*, *Willis W.*, and *Blanton*, *Franklin S.*
blantoni, *Culicoides*, 346, 347
boletina, *Milichia*, 229
Odinia, 223, 226, 229
Boltenia *echinata*, 160
ovifera, 160
borealis, *Astarte*, 71, 165, 168, 178, 191
Trichotropis, 68, 88
Boreotrophon, 65, 66, 97, 102
beringi, 69, 99, 100
cephalus, 98
clathratus, 69, 98, 99
clathratus *gunneri*, 98, 99
clathratus *scalariformis*, 98
multicostatus, 98
pacificus, 69, 100, 102
truncatus, 69, 100, 101
borinqueni, *Culicoides*, 332
Brachoria, 1, 2, 3, 8-10 (key), 13 (figs.), 15, 33, 40, 42, 44, 49, 50, 52, 53 (map), 56
benderi, 2, 11, 14, 15
brachypus, 2, 11, 14, 15
calcaria, 6, 8, 13 (fig.), 15, 43, 44, 53, 56
calceata, 9, 13 (fig.), 16, 39, 40, 54, 55, 56
cedra, 9, 11, 17, 19 (fig.), 20, 44, 54, 56
dentata, 7, 8, 18, 19 (fig.), 36, 55, 56, 57
electa, 2, 7, 8, 9, 11, 17, 19 (fig.), 20, 49, 54, 56
ethotela, 2, 23, 25, 26, 30, 56
eutypa, 2, 7, 21, 24 (fig.), 26, 53, 56, 57
eutypa *ethotela*, 10, 22, 23, 24 (fig.)
eutypa *eutypa*, 10, 21, 23, 24 (fig.), 55
falcifera, 10, 27, 29 (fig.), 55, 56
glendalea, 7, 9, 28, 29 (fig.), 55, 56
hamata, 10, 26, 29 (fig.), 30, 53, 56
hansonii, 2, 9, 21, 22, 23, 31, 32 (fig.), 33, 34, 44, 52, 55, 56
hoffmani, 6, 7, 8, 9, 27, 31, 32 (fig.), 39, 49, 54, 55, 56

- Brachoria*, *hubrichti*, 7, 10, 31, 32 (fig.), 33, 44, 55, 56
indianae, 9, 11, 17, 20, 27, 34, 37 (fig.), 54, 55, 56
initialis, 2, 3, 4, 5, 8, 11, 14, 15, 21, 34, 48
insolita, 5, 7, 8, 18, 20, 26, 36, 37 (fig.), 42, 55, 56, 57
kentuckiana, 8, 37 (fig.), 38, 40, 54, 55, 56
laminata, 6, 7, 9, 27, 31, 39, 41 (fig.), 54, 55, 56
ligula, 7, 9, 40, 41 (fig.), 54, 55, 56
mendota, 10, 36, 38, 41 (fig.), 42, 57
ochra, 7, 8, 10, 14, 17, 18, 20, 21, 44, 54, 56
ochra initialis, 3, 9, 11, 13 (fig.), 21, 54
ochra ochra, 9, 10, 11
pecta, 9, 21, 22, 23, 27, 43, 46 (fig.), 53, 55, 56, 57
separanda, 2, 5, 9, 11, 15, 16, 17, 20, 21, 22, 23, 31, 33, 34, 43, 44, 46 (fig.), 52, 53, 54, 56, 57
sequens, 2, 10, 11, 14, 15
splendida, 9, 46 (fig.), 47, 54, 55, 56
tenebrans, 10, 17, 47, 51 (fig.), 54, 56
turneri, 6, 7, 10, 49, 51 (fig.), 53, 55, 56
viridicolens, 8, 50, 51 (fig.), 54, 55, 56
brachypus, *Brachoria*, 2, 11, 14, 15
brasiliensis, *Calisiopsis*, 222
bricenoi, *Culicoides*, 397
Buccinidae, 69, 102
buccinoides, *Cancellaria*, 129
Buccinum, 65, 66, 69, 102
 angulosum, 66, 67, 69, 103, 109, 110, 111, 112, 114, Pls. 10, 11, 17
 angulosum cnismatopleura, 109, 111, 112
 angulosum normale, 66, 67, 69, 109, 110, 111, 112
 angulosum subcostatum, 66, 67, 69, 109, 110, 111, 112
 angulosum transliratum, 66, 69, 109, 111, 112
 carinatum, 102
 ciliatum, 69, 105, 108, 110, 112, 113, 114
 cnismatopleura, 109
 donovani, 104
 fringillum, 69, 112
 glaciale, 66, 69, 102, 104, 105
 glaciale morchianum, 69, 102, 104
 glaciale parallelum, 102, 104
 morchianum, 102
 orotundum, 108, 109
 pemphigus orotundum, 108, 109
 plectrum, 66, 69, 105
 polare, 66, 69, 108
 polaris, 108
 pyramidale, 136
 saturum, 121
 solutum, 122, 124, 125, 126
 stimpsoni, 115
Buccinum, *tenuis*, 66, 69, 103, 106, 107, 108
 tenuis rhodium, 106, 107, 108
 truncatum, 101
 undatum, 69, 114, 126
 undatum striatum, 69, 114
 ventricosum, 121
Bulla debilis, 139
 hiemalis, 139
 hyalina, 139
 occulta, 140
 plicatilis, 96
 reinhardti, 140
 scalpta, 140
 striata, 140
 subangulata, 139
 unbilicata, 138
 velutina, 95
caezelus, *Culicoides*, 337, 339
caeca, *Lepeta*, 68, 73
cacoides, *Lepeta*, 73, 74
calcaratus, *Scotobates*, 229
calcareia, *Macoma*, 71, 167, 181
 Tellina, 181
calcaria, *Brachoria*, 6, 8, 13 (fig.), 15, 43, 44, 53, 56
calceata, *Brachoria*, 9, 13 (fig.), 16, 39, 40, 54, 55, 56
 Tucoria, 2, 6, 16
Calisiinae, 209, 210 (key)
Calisiopsis, 210, 211, 213 (figs.), 220
 ampleps, 212, 213 (fig.), 220, 221, 222
 brasiliensis, 222
 minutus, 212, 213 (fig.), 221
Calisius, 210, 211, 213 (figs.)
 affinis, 214, 216, 217
 annulicornis, 209, 219
 australis, 212, 213 (fig.), 218, 219, 220
 bilobatus, 212, 213 (fig.), 214
 confusus, 214, 215
 contubernalis, 216
 gracilis, 211, 212, 213 (fig.), 214
 hackeri, 212, 213 (fig.), 219
 insignis, 212, 213 (fig.), 215, 218
 longiventris, 212, 213 (fig.), 216
 pallipes, 211
 salicis, 209
camposi, *Culicoides*, 244, 246, 260, 266, 349, 356, 357 (fig.), 360
Cancellaria buccinoides, 129
 couthouyi, 129
 middendorffiana, 130
 viridula, 129
Cancellariidae, 69, 129
candida, *Diaphana*, 139
candidus, *Utriculus*, 139
capponius, *Colus*, 69, 120
caprilesi, *Culicoides*, 244, 245, 246, 262, 271, 454, 456, 457 (fig.), 461, 464
Cardiidae, 71, 176
Cardita, 169
 borealis crebricostata, 169
 borealis paucicostata, 170
 crassidens, 71, 166, 170
 crebricostata, 71, 169

- Cardita*, paucicostata, 171
 ventricosa, 169
Carditidae, 71, 169
Cardium ciliatum, 176
 grönlandicum, 176
carinatum, Buccinum, 102
 Tritonium, 102
carpenteri, Culicoides, 245, 261, 266,
 349, 358, 359 (fig.)
carsiomelas, Culicoides, 244, 261, 272,
 363, 365, 366 (fig.), 369
cassandra, Odostomia, 70, 141
castanea, Cingula, 68, 84, 85
 Rissoa, 84
castillae, Culicoides, 244, 245, 248, 249,
 261, 272, 273, 407, 416, 417
 (fig.), 420, 447
Cavanillesia, 243
Cecropia arachnoides, 243
cedra, Brachoria, 9, 11, 17, 19 (fig.),
 20, 44, 54, 56 (graph)
Cedrela, 243
Cephalopoda, 70, 148
cephalus, Boreotrophon, 98
Ceratopogon maculithorax, 404, 407
 obsoletus, 290
 phlebotomus, 468, 469
 punctatus, 294
Cereus gigantea, 247
Cerithium perversum, 87
Chiton albus, 145
 vestitus, 147
Chitonida, 70
Chlamys, 155
 islandica, 70, 155, 156
Chrysodomus heros, 122
 saturus, 121, 123
 saturus communis, 122, 123
 solutus, 122, 123, 124, 126
 solutus variciferus, 121, 122
 variciferus, 121, 122
 vinosus, 124
chrysonotus, Culicoides, 246, 260, 264,
 308, 310, 311, 312 (fig.)
Chrysophyllum, 243
ciliatum, Buccinum, 69, 105, 108, 110,
 112, 113, 114
 Cardium, 176
 Clinocardium, 71, 176
 Tritonium, 113
cinera, Margarita, 75
 Margarites, 75
cinereus, Turbo, 75
Cingula, 84
 castanea, 68, 84, 85
 castanea alaskana, 84
Cirroteuthidae, 70, 148
Cirroteuthis, 67, 70, 148
 hoylei, 149
 sp., 70, 148
Cladohepatica, 144
clathratus, Boreotrophon, 69, 98, 99
 Murex, 98
 Trophon, 97, 98
clausa, Natica, 68, 89, 90
Cleptoria kentuckiana, 38
 splendida, 2, 6, 47
Clinocardium, 176
 ciliatum, 71, 176
Clio helicina, 142
 limacina, 143
Clione, 143
 limacina, 70, 143
Clionidae, 70, 143
cnismatopleura, Buccinum, 109
 Buccinum angulosum, 109, 111, 112
coccinea, Stomphia, 164
coeca, Petella, 73
Colus, 119
 capponius, 69, 120
 martensi, 69, 120
 spitsbergensis, 69, 119
 spitzbergensis, 119
commatis, Culicoides, 245, 260, 268, 314,
 321, 322 (fig.)
commodum, Pilidium, 93
commodus, Piliscus, 68, 93
communis, Chrysodomus saturatus, 122,
 123
 Tritonium antiquum, 123
compressa, Pseudopythina, 71, 173
 Venus, 167
concentrica, Lepeta, 73, 74
confusus, Calisius, 214, 215
conspicua, Odinia, 224, 225, 228
contubernalis, Calisius, 216
 Culicoides rozeboomi, 278
copiosus, Culicoides, 247, 314, 332, 336
coriacea, Helix, 96, 97
 Velutina, 97
corica, Rimula, 75
Coriella stolonata, 147
corneus, Turbo, 75
coronata, Odinia, 226, 232, 234, 235, 236
corrugata, Modiolaria, 158
corrugatus, Musculus, 71, 158, 160, 161,
 21
 Mytilus, 158
Coryphella, 145
 salmonacea, 70, 145
costalis, Margarites, 75
 Trochus, 75
costulata, Margarita, 81
 Molleria, 68, 81
couthouyi, Admete, 66, 69, 129, 130, 131
 Cancellaria, 129
covagargiai, Culicoides, 245, 246, 260,
 264, 299, 304, 305 (fig.), 307
crassicutis, Fontaria, 10
crassidens, Astarte, 170
 Cardita, 71, 166, 170
 Venericardia, 170
crebricostata, Cardita, 71, 169
 Cardita borealis, 169
 Venericardia, 169
Crepidula, 87
 grandis, 68, 87
Crepidulidae, 68, 87
crescentis, Culicoides, 244, 260, 267, 314,
 317 (fig.)
crispa, Admete, 129

Cryptochitonidae, 70, 147
 cryptospira, *Velutina*, 96
 Velutina plicatilis, 96
 Ctenobranchia, 68, 83
 Culex pulicarius, 294
 Culicoides, 237, 238, 239, 245, 246, 247,
 248, 251, 258, 249, 262 (key)
 acotylus, 244, 245, 261, 269, 314,
 363, 367, 368 (fig.)
 acotylus group, 261, 362, 365
 aethionotus, 363, 365
 alahialinus, 245, 261, 265, 398, 399
 (fig.), 402, 404, 468
 almirantei, 245, 262, 271, 454, 455
 (fig.), 459
 amazonius, 469
 antefurcatus, 244, 260, 268, 314, 315
 (fig.), 317, 319, 321, 356
 arubae, 245, 246, 248, 249, 262, 265,
 314, 464, 465 (fig.)
 arubae group, 262, 464
 aureus, 244, 262, 272, 431, 447, 448
 (fig.), 451
 avilaensis, 338, 389, 390
 azureus, 245, 261, 271, 377 (fig.),
 384, 395
 bakeri, 341, 342
 balsapambensis, 244, 261, 272, 273,
 407, 414 (fig.)
 barbosai, 245, 249, 261, 272, 398,
 399, 400 (fig.), 404
 baueri, 346
 beebei, 304
 benarrochei, 428
 bimaculatus, 280
 blantonii, 346, 347
 borinqueni, 332
 bricenoi, 397
 cacozelus, 337, 339
 camposi, 244, 246, 260, 266, 349,
 356, 357 (fig.), 360
 caprilesi, 244, 245, 246, 262, 271,
 454, 456, 457 (fig.), 461, 464
 carpenteri, 245, 261, 266, 349, 358,
 359 (fig.)
 carsiomelas, 244, 261, 272, 363,
 365, 366 (fig.), 369
 castillae, 244, 245, 248, 249, 261,
 272, 273, 407 416 417 (fig.), 420,
 447
 chrysonotus, 246, 260, 264, 308,
 310, 311, 312 (fig.)
 commatis, 245, 260, 268, 314, 321,
 322 (fig.), 326
 copiosus, 247, 314, 332, 336
 copiosus group, 260, 328, 332, 356
 covagarciai, 245, 246, 260, 264, 299,
 304, 305 (fig.), 307
 covagarciai group, 260, 294, 298
 crepuscularis group, 258
 crescentis, 244, 260, 267, 314, 317
 (fig.)
 daedaloides, 244, 260, 267, 314, 330
 (fig.)
 daedalus, 245, 260, 267, 314, 319,
 320 (fig.), 327, 331, 334

Culicoides, *daedalus* group, 260, 314,
 329, 332, 356, 362
 dampfii, 347, 349
 dasyophrus, 416, 428
 debilipalpis, 244, 245, 246, 248,
 249, 262, 270, 314, 420, 423, 431,
 442, 443 (fig.), 447
 debilipalpis glabrier, 452, 453
 debilipalpis group, 262, 431, 442,
 451, 453
 decor, 308, 309, 310, 313
 diabolicus, 239, 244, 245, 246, 249,
 253 (fig.), 259, 263, 280, 281 (fig.),
 283
 dierourus, 244, 245, 246, 261, 271,
 377, 386, 387 (fig.), 390
 diminutus, 287, 288, 289, 290
 discrepans, 388, 389, 390
 dominicii, 324
 donajii, 424
 dovei, 404, 405
 dunni, 246, 260, 266, 267, 314, 328
 (fig.)
 efferus, 246, 260, 264, 299, 300 (fig.),
 302, 304
 elutus, 244, 245, 246, 260, 264, 295,
 296 (fig.)
 equatoriensis, 445
 eublepharus, 424
 evansi, 260, 267, 342, 343 (fig.), 346,
 347
 fairchildi, 356, 358
 fernandezi, 409
 fieldi, 261, 270, 427 (fig.)
 filariferus, 280, 282, 283
 flochabonnenci, 416, 418
 fluvialis, 244, 245, 261, 272, 314,
 407, 408 (fig.)
 fluvialis group, 261, 407, 453
 foxi, 244, 249, 259, 263, 280, 282,
 283, 284 (fig.)
 furens, 239, 245, 246, 248, 249, 250,
 254 (fig.), 261, 268, 314, 372, 398,
 402, 404, 405 (fig.)
 furens group, 261, 397, 468
 gabaldoni, 244, 246, 262, 270, 430,
 431, 432 (fig.)
 galindoi, 244, 245, 260, 265, 271,
 317, 349, 350 (fig.), 353, 356, 358,
 360, 362, 365
 germanus, 431, 445, 453
 gibsoni, 416, 418
 ginesi, 244, 246, 262, 269, 431, 449,
 450 (fig.)
 glabellus, 261, 270, 426, 428, 429
 (fig.), 433
 glabrior, 244, 262, 270, 431, 452
 (fig.)
 gorgasi, 245, 246, 261, 272, 398, 399,
 402, 403 (fig.), 468
 grahambelli, 452
 guttatus, 280, 282, 283, 285
 guttatus group, 259, 273, 280
 guyanensis, 245, 248, 249, 261, 268,
 363, 370, 371 (fig.)

- Culicoides, helieoniae*, 248, 259, 263, 274, 275 (fig.), 277, 278, 279, 280
hertigi, 337, 339
hoffmani, 248, 262, 270, 431, 435, 436 (fig.), 439, 445, 449, 451
horticola, 433
hylas, 244, 245, 246, 248, 259, 263, 274, 276, 277 (fig.), 280
hylas group, 259, 273
imitator, 245, 246, 262, 270, 431, 433, 435, 438 (fig.), 445
inamollae, 273, 285, 287
insignis, 244, 245, 246, 248, 259, 263, 280, 282, 285, 286 (fig.)
insinuatus, 445
iriartei, 245, 246, 260, 266, 314, 344, 345 (fig.)
iriartei group, 260, 342, 356
jamaicensis, 239, 244, 246, 248, 260, 266, 332, 339, 340 (fig.)
kintzi, 456, 458
lanei, 244, 261, 269, 314, 363, 372, 374, 375 (fig.)
leoni, 430, 433
leoni group, 261, 426
leopoldoi, 244, 245, 246, 261, 272, 407, 418, 419 (fig.)
lichyi, 416
limai, 245, 260, 266, 314, 349, 351, 352 (fig.), 356, 360, 365
limai group, 260, 261, 271, 316, 349, 362
lopesi, 456
loughnani, 332, 341
loughnani jamaicensis, 339
lutealaris, 246, 260, 264, 308, 310, 311 (fig.), 313
luteovenus, 246, 248, 249, 260, 264, 295, 296, 297 (fig.)
lyrinotatus, 245, 261, 269, 377, 391, (fig.), 395
macrostigma, 244, 261, 272, 376, 377, 395, 396 (fig.)
magnipalpis, 246, 261, 269, 349, 360, 361 (fig.)
marshi, 245, 260, 264, 299, 302, 303 (fig.)
marum, 289
metagonatus, 245, 246, 260, 263, 264, 299, 306 (fig.)
mirsaе, 262, 269, 431, 446 (fig.)
miyamotoi, 447
mojingaensis, 244, 261, 271, 377, 379, 380 (fig.), 381, 384, 395, 397
nigrigenus, 244, 245, 246, 260, 265, 308, 309 (fig.), 313
nigrigenus group, 260, 294, 299, 307
nubeculosus group, 466
obnoxius, 454, 456
obsoletus group, 258
ocumarensis, 280
oliveri, 287
ortizi, 372
pachymerus, 244, 249, 262, 264, 314, 454, 456, 458, 459, 460 (fig.), 464
pachymerus group, 262, 454, 468
- Culicoides, painteri*, 285, 287
palpalis, 274, 278
pam-poikilus, 245, 246, 260, 268, 314, 323, 324 (fig.)
panamensis, 244, 245, 248, 249, 260, 266, 332, 334, 335 (fig.), 339
panamericanus, 367
paraensis, 244, 245, 246, 249, 262, 268, 431, 440, 441 (fig.)
patulipalpis, 244, 246, 261, 270, 421, 421 (fig.), 424, 426
paucienfuscatus, 261, 265, 277, 381, 382 (fig.), 393
phaenotus, 245, 260, 268, 314, 326 (fig.), 334
phlebotomus, 245, 246, 248, 249, 262, 267, 372, 469, 470 (fig.), 473
phlebotomus group, 258
pictipennis, 372
pifanoi, 244, 246, 248, 261, 265, 277, 384, 385 (fig.), 416
pilosus, 244, 260, 268, 328, 332, 333 (fig.)
poikilonotus, 244, 260, 267, 269, 329, 332, 337 (fig.)
propinquus, 329, 332
propriipennis, 244, 245, 261, 268, 407, 411, 412 (fig.), 426
pseudodiabolicus, 280
pulicaris group, 260, 294
pusilloides, 244, 245, 259, 263, 290, 291 (fig.)
pusillus, 244, 246, 248, 249, 259, 263, 265, 292, 293 (fig.)
pusillus group, 290
rangeli, 245, 246, 261, 273, 421, 422, 423 (fig.), 426, 445
recifensis, 370
reticulatus, 245, 246, 248, 249, 261, 272, 314, 377, 393 (fig.)
reticulatus group, 261, 376
rostratus, 246, 260, 264, 299, 301 (fig.), 304
rozeboomi, 274, 276
rozeboomi contubernalis, 278
scopus, 245, 246, 260, 266, 314, 347, 348 (fig.)
scopus group, 260, 347
spurius, 244, 262, 271, 431, 433, 434 (fig.)
stellifer, 370
stigmalis, 245, 249, 262, 265, 314, 466, 467 (fig.)
stigmalis group, 262, 466
stubalensis, 370
tenuilobus, 244, 260, 267, 316, 349, 351, 354 (fig.)
tetrathyrus, 244, 261, 269, 407, 409, 410 (fig.), 414, 426
transferrans, 245, 246, 261, 273, 314, 421, 422, 424, 425 (fig.), 445
transferrans group, 261, 420
tricoloratus, 384, 386
trilineatus, 445
trinidadensis, 245, 246, 248, 249, 259, 263, 280, 287, 288 (fig.)
undecimpunctatus, 440

- Culicoides*, uniradialis, 244, 245, 246, 262, 264, 454, 456, 461, 462 (fig.)
 variipennis, 466
 venezuelensis, 246, 261, 267, 268, 314, 363, 372, 373 (fig.)
 verecundus, 244, 248, 259, 263, 274, 278, 279 (fig.)
 volcanensis, 246, 261, 270, 273, 377, 389 (fig.)
 willistoni, 245, 246, 262, 267, 372, 469, 471, 472 (fig.)
 wokei, 245, 246, 271, 288, 290, 363, 364 (fig.), 401
 sp., 274, 319
 subg., 258, 260, 294, 299, 308
curta, Thracia, 162, 163
Cyclodonta, 176
Cylichna, 140
 magna, 141
 nitidula, 138
 occulta, 66, 70, 140
 occulta occulta, 141
 occulta sculpta, 141
 propinqua, 140
 solitaria, 140
 strigella, 138
daedaloides, *Culicoides*, 244, 260, 267, 314, 330 (fig.)
daedalus, *Culicoides*, 245, 260, 267, 314, 319, 320 (fig.), 327, 331, 334
Dalbergia retusa, 243
dampfi, *Culicoides*, 347, 349
dasyophrus, *Culicoides*, 416, 428
dawsoni, *Montacuta*, 174
debilipalpis, *Culicoides*, 244, 245, 246, 248, 249, 262, 270, 314, 420, 423, 431, 442, 443 (fig.), 447
debilis, Bulla, 139
 Diaphana, 140
Decapoda, 70, 148
decor, *Culicoides*, 308, 310, 313
deformis, *Fusus*, 114
Pyrulofusus, 69, 114
Defrancia elegans, 135
 vahlhi, 136
 woodiana, 135
Dendrobenia murrayana, 160
Dendronotidae, 70, 144
Dendronotus, 144
 arborescens, 144
 frondosus, 70, 144
 sp., 70, 145
Dendrophthora sp., 244
dentata, *Brachoria*, 7, 8, 18, 19 (fig.), 36, 55, 56, 57
despecta, *Neptunea*, 124
despectus, *Murex*, 124
diabolicus, *Culicoides*, 239, 244, 245, 246, 249, 253 (fig.), 259, 263, 280, 281 (fig.), 283
Diaphana, 65, 139
 candida, 139
Diaphana, debilis, 140
 expansa, 139
 glacialis, 139
 globosa, 139, 140
 hiemalis, 139, 140
 hyalina, 139, 140
 minuta, 70, 139, 140
 minuta hiemalis, 139
 minuta minuta, 139
 spirata, 139
Diaphanidae, 70, 139
dierourus, *Culicoides*, 244, 245, 246, 261, 271, 377, 386, 387 (fig.), 390
diminutus, *Culicoides*, 287, 288, 289, 290
Diogenodonta, 164
Diplodonta, 172
 aleutica, 71, 172
Diplopoda, 1
Dipteryx panamensis, 243
discors, *Modiola*, 158
Modiolaria, 159
Musculus, 71, 159, 161, 162
Mytilus, 159
discrepans, *Culicoides*, 388, 389, 390
Docoglossa, 73
dominicii, *Culicoides*, 324
donajai, *Culicoides*, 424
donovani, *Buccinum*, 104
Doridacea, 143
Dorididae, 70, 143
Doris arborescens, 144
 zetlandica, 143
dovei, *Culicoides*, 404, 405
drobachiensis, *Strongylocentrotus*, 124
dunni, *Culicoides*, 246, 260, 266, 267, 314, 328 (fig.)
dynama, *Tucoria*, 2, 6, 47, 48
Dysodonta, 157
echinata, *Boltenia*, 160
edulis, *Mytilus*, 71, 157
efferus, *Culicoides*, 246, 260, 264, 299, 300 (fig.), 302, 304
electa, *Brachoria*, 2, 7, 8, 9, 11, 17, 19 (fig.), 20, 49, 54, 56
elegans, *Bela*, 135
Defrancia, 135
Oenopota, 69, 135
elutus, *Culicoides*, 244, 245, 246, 260, 264, 295, 296 (fig.)
elvata, *Montacuta*, 174
ensifera, *Yoldia*, 154
Eolis salmonacea, 145
Epitoniidae, 68, 83
Epitonium, 83
 greenlandicum, 68, 83
 groenlandicum, 83
equitoriensis, *Culicoides*, 445
erecta, *Tricellaria*, 159, 191
erosum, *Tachyrhynchus*, 86
ethotela, *Brachoria*, 2, 23, 25, 26, 30, 56
Brachoria eutypa, 10, 22, 23, 24 (fig.)
eublepharus, *Culicoides*, 424
Eucratea loricata, 160, 191
Euspira monterona, 91
Euthyneura, 138

- eutypa, *Brachoria*, 2, 7, 24 (figs.), 25,
 26, 53, 56, 57
 Brachoria eutypa, 10, 21, 23, 24
 (fig.), 55
Euzophera ostricorella, 232
evansi, *Culicoides*, 260, 267, 342, 343
 (fig.), 346, 347
expansa, *Amphisphyra*, 139
 Diaphana, 139
 Nucula, 149
expansus, *Utricular*, 139

fabricii, *Gonatus*, 70, 148
 Onychoteuthis, 148
 Psolus, 174
fabula, *Astarte*, 167
 Astarte montagui, 168
fairchildi, *Culicoides*, 356, 358
falcifera, *Brachoria*, 10, 27, 29 (fig.), 55,
 56
falklandica, *Puncturella*, 75
fernandezi, *Culicoides*, 409
Ficus, 243
fieldi, *Culicoides*, 261, 270, 427 (fig.)
filariferus, *Culicoides*, 280, 282, 283
Fissurellidae, 74
Flabellinidae, 70, 145
flexuosa, *Lucina*, 171
 Tellina, 171
 Thyasira, 71, 171; Pl. 4
 Venus, 171
flexuosus, *Axinus*, 171
 Flies of the genus *Odinia* in the Western
 Hemisphere (Diptera: *Odiinidae*),
 223
flochabonnenci, *Culicoides*, 416, 418
fluctuosa, *Lioceyma*, 71, 177, 179
 Tapes, 171, 177
 Venus, 177
fluvialis, *Culicoides*, 244, 245, 261, 272,
 314, 407, 408 (fig.)
Fontaria crassicutis, 10
 glendalea, 2, 28
 indianae, 2, 34
 kentuckiana, 2, 3, 6, 38
 ochra, 2, 10
fornicatus, *Fusus*, 122
foxi, *Culicoides*, 244, 249, 259, 263, 280,
 282, 283, 284 (fig.)
frigidus, *Margarites*, 68, 78
fringillum, *Buccinum*, 69, 112
frondosa, *Amphitrite*, 144
frondosus, *Dendronotus*, 70, 144
Fucus sp., 161
furens, *Culicoides*, 239, 245, 246, 248,
 249, 250, 254 (fig.), 261, 268, 314,
 372, 398, 402, 404, 405 (fig.)
 Oecacta, 314, 404
Fusinidae, 69, 129
Fusus deformis, 114
 fornicatus, 122
 harpularius, 135
 kroyeri, 126
 lamellosus, 98, 99
 pleurotomarius, 136

Fusus deformis scalariformis, 98
 spitzbergensis, 119
 verkruzeni, 126
 subg., 117, 122

gabaldoni, *Culicoides*, 244, 246, 262,
 270, 430, 431, 432 (fig.)
galindoi, *Culicoides*, 244, 245, 260, 265,
 271, 317, 349, 350 (fig.), 353, 356,
 358, 360, 362, 365
Gastropoda, 68-70, 73
germanus, *Culicoides*, 431, 445, 453
gibsoni, *Culicoides*, 416, 418
gigantea, *Cereus*, 247
 "Oenopota" pyramidalis, 136
ginesi, *Culicoides*, 244, 246, 262, 269,
 431, 449, 450 (fig.)
glabellus, *Culicoides*, 261, 270, 426,
 428, 429 (fig.) 433
glaber, *Polypus*, 149
glabrior, *Culicoides*, 244, 262, 270, 431,
 452 (fig.)
 Culicoides debilipalpis, 452, 453
glaciale, *Buccinum*, 66, 69, 103, 104,
 105; Pl. 9
glacialis, *Diaphana*, 139
 Lamellaria, 92
 Onchidiopsis, 68, 92, 93
glendalea, *Brachoria*, 7, 9, 28, 29 (fig.),
 55, 56
 Fontaria, 2, 28
globosa, *Amphisphyra*, 139
 Astarte, 167
 Astarte montagui, 167, 168
 Diaphana, 139, 140
Glycimeris arctica, 189
Golfingia margaritacea, 160
Gonatidae, 70, 148
Gonatus, 67, 148
 amoenus, 148
 fabricii, 70, 148
gorbunovi, *Barentsia*, 160
gorgasi, *Culicoides*, 245, 246, 261, 272,
 393, 399, 402, 403 (fig.), 468
gouldi, *Thyasira flexuosa*, 171, 172
gouldii, *Axinus*, 171
 Lucina, 171
 Thyasira, 171
gracilis, *Calisius*, 211, 212, 213 (fig.),
 214
grahambelli, *Culicoides*, 452
grandidentata, *Populus*, 229
grandis, *Crepidula*, 68, 87
 Margarita cinerea, 75, 76, 77
 Margarites costalis, 68, 76
grebnitzski, *Rochefortia*, 175
greenlandica, *Scalaria*, 83
greenlandicum, *Epitonium*, 68, 83
groenlandica, *Onchidiopsis*, 68, 93
groenlandicum, *Epitonium*, 83
groenlandicus, *Serripes*, 176
gronlandica, *Montacuta ferruginosa*, 174
grönlandicum, *Cardium*, 176
grönlandicus, *Polinices*, 92
 Serripes, 71, 176
grosvenori, *Margarites*, 80
 Margaritopsis, 67, 68, 80

- guajava, *Psidium*, 243
gunneri, *Boreotrophon clathratus*, 98;
 pl. 7
 Tritonium, 98
 Trophon clathratus, 98
guttatus, *Culicoides*, 280, 282, 283, 285
guyanensis, *Culicoides*, 245, 248, 249,
 261, 268, 363, 370, 371 (fig.)
hackeri, *Calisius*, 212, 213 (fig.), 219
Haematomyidium, 314
 paraense, 314, 440
hamata, *Brachoria*, 10, 26, 29 (fig.), 30,
 53, 56
hansonii, *Brachoria*, 2, 9, 21, 22, 23, 31,
 32 (fig.), 33, 34, 44, 52, 55, 56
harpa, *Bela*, 134
 Oenopota, 66, 134
harpularia, *Bela*, 135
 Lora, 135
 Oenopota, 69, 135
harpularius, *Fusus*, 135
Heleidae, 239
helicina, *Clio*, 142
 Limacina, 142
 Spiratella, 70, 142
Heliconia, 247, 276
 mariae, 248, 418
heliconiae, *Culicoides*, 248, 259, 263, 274,
 275 (fig.), 277, 278, 279, 280
Helix coriacea, 96, 97
hendeli, *Odinia*, 228
heros, *Chrysodomus*, 122
 Neptunea, 69, 122, 123, 125, 126
hertigi, *Culicoides*, 337, 339
Hiatella, 190
 arctica, 71, 156, 160, 167, 190
 rugosa, 191
 striata, 191
Hiatellidae, 67, 71, 189
Hicoria sp., 232
hiemalis, *Bulla*, 139
 Diaphana, 139, 140
 Diaphana minuta, 139
hoffmani, *Brachoria*, 6, 7, 8, 9, 27, 31,
 32 (fig.), 39, 49, 54, 55, 56
hoffmani, *Culicoides*, 248, 262, 270, 431,
 435, 436 (fig.), 439, 445, 449, 451
Hoffmania, subg., 253, 259, 273, 285, 299
hokkaidensis, *Benthocopus*, 70, 149
 Octopus, 149
 Polypus, 149
Holohepatica, 143
horticola, *Culicoides*, 433
hoylei, *Cirroteuthis*, 149
hubrichti, *Brachoria*, 7, 10, 31, 32 (fig.),
 33, 44, 55, 56
hyalina, *Bulla*, 139
 Diaphana, 139, 140
hylas, *Culicoides*, 244, 245, 246, 248, 259,
 263, 274, 276, 277 (fig.), 280
hyperborea, *Nucula*, 152
 Yoldia, 70, 152
imitator, *Culicoides*, 245, 246, 262, 270,
 431, 433, 435, 438 (fig.), 445
immaculata, *Odinia*, 223, 224
impressa, *Bela*, 137
 Nodotoma, 69, 137
 Pleurotoma, 137
inaequalis, *Axinopsida orbiculata*, 172
inamollae, *Culicoides*, 273, 285, 287
incongrua, *Macoma*, 71, 180
 Tellina, 180
indianae, *Brachoria*, 9, 11, 17, 20, 27,
 34, 37 (fig.) 54, 55, 56
 Fontaria, 2, 34
initialis, *Brachoria*, 2, 3, 4, 5, 8, 11, 14,
 15, 21, 34, 48
 Brachoria ochra, 3, 9, 11, 13 (fig.),
 21, 54
insignis, *Calisius*, 212, 213 (fig.), 215,
 218
insignis, *Culicoides*, 244, 245, 246, 248,
 259, 263, 280, 282, 285, 286 (fig.)
insinuatus, *Culicoides*, 445
insolita, *Brachoria*, 5, 7, 8, 18, 20, 26,
 36, 37 (fig.), 42, 55, 56, 57
instabilis, *Lepeta alba*, 73, 74
intermedia, *Mya*, 186, 187, 188
iriartei, *Culicoides*, 245, 246, 260, 266,
 314, 344, 345 (fig.)
islandica, *Chlamys*, 70, 155, 156
islandicus, *Pecten*, 155
Isoderminea, 209
Isodonta, 155
jamaicensis, *Culicoides*, 239, 244, 246,
 248, 260, 266, 332, 339, 340 (fig.)
 Culicoides loughnani, 339
jan-mayeni, *Alvania*, 68, 85
 Rissoa, 85
japonica, *Mya*, 186, 187, 188, 189
jenisseensis, *Pleurotoma pyramidalis*,
 136
Keeton, William T.; A revision of the
 milliped genus *Brachoria* (Poly-
 desmida: Xystodesmidae), 1
kentuckiana, *Brachoria*, 8, 37 (fig.), 38,
 40, 54, 55, 56
 Cleptoria, 38
 Fontaria, 2, 3, 6, 38
 Tucoria, 38
kintzi, *Culicoides*, 456, 458
Kleptoria splendida, 2
kobelti, *Beringius beringi*, 69, 117, 118,
 119
 Volutopsius, 117
 Volutopsius beringii, 117, 118
Kormilev, Nicholas A.; Notes on Aradi-
 dae in the U.S. National Museum
 (Hemiptera), subfamily *Calisii-*
 nae, 209
krausei, *Macoma*, 182, 183, 184
kroyeri, *Fusus*, 126
 Plicifusus, 69, 126
 Sipho, 126
 Trichotropis, 68, 89

- Lacunidae, 68, 83
 laevigata, Bela, 133
 Modiola, 159
 Modiolaria, 159, 162
 Modiolaria discors, 159
 Velutina, 95
 laevigatus, Musculus, 159, 160
 Musculus discors, 71, 159, 160, 161, 162
 laevior, Admete couthouyi, 129
 Lamellaria glacialis, 92
 Lamellariidae, 66, 68-69, 92
 lamellosus, Fusus, 98, 99
 laminata, Brachoria, 6, 7, 9, 27, 31, 39, 41 (fig.), 54, 55, 56 (graph)
 Lampeia, subg., 163
 lanei, Culicoides, 244, 261, 269, 314, 363, 372, 374, 375 (fig.)
 lanigera, Velutina, 69, 97
 lavarum, Acretyophyllum, 244
 Leda arctica, 151
 minuta, 150
 pernula radiata, 151
 radiata, 151
 leoni, Culicoides, 430, 433
 leopoldoi, Culicoides, 244, 245, 246, 261, 272, 407, 418, 419 (fig.)
 Lepeta, 73
 alba, 73, 74
 alba instabilis, 73, 74
 caeca, 68, 73, Pl. 4
 caecoides, 73, 74
 concentrica, 73, 74
 Lepetidae, 68, 73
 Lepidochitonidae, 70, 145
 Leptonidae, 65, 67, 71, 173
 lichyi, Culicoides, 416
 ligatus, Ptychatractus, 129
 ligula, Brachoria, 7, 9, 40, 41 (fig.), 54, 55, 56
 limacina, Clio, 143
 Clione, 70, 143
 helicina, 142
 pacificia, 142
 limai, Culacoides, 245, 260, 266, 314, 349, 351, 352 (fig.), 356, 360, 365
 limatula, Yoldia, 153, 154
 limatuloides, Yoldia hyperborea, 153, 154
 Liocyma, 65, 71, 177, 179
 aniwana, 177, 178, 179
 beckii, 177, 178, 179
 fluctuosa, 71, 177, 179
 scammoni, 177, 178, 179
 schefferi, 177, 178, 179
 viridis, 177, 178, 179
 sp., 179
 Liotiidae, 68, 81
 longiventris, Calisius, 212, 213 (fig.), 216
 lopesi, Culicoides, 456
 Lora, 132
 harpularia, 135
 nazanensis, 134
 tenuilrata, 132
 loricata, Eucratea, 160, 191
 loughnani, Culicoides, 332, 341
 Lucina flexuosa, 171
 gouldii, 171
 Lunatia pallida, 91
 lutea, Tellina, 71, 180
 lutealaris, Culicoides, 246, 260, 264, 308, 310, 311 (fig.), 313
 luteovenus, Culicoides, 246, 248, 249, 260, 264, 295, 296, 297 (fig.)
 lutescens, Yoldia arctica, 151, 152
 Lyonsia, 164
 norvegica, 71, 164
 Lyonsiidae, 71, 164
 lyrinotatus, Culicoides, 245, 261, 269, 377, 391 (fig.), 395
 Macfiella, subg. 256, 258, 262, 372, 468
 MacGinitie, Nettie; Marine mollusca of Point Barrow, Alaska, 59
 Macoma, 61, 71, 180
 balthica, 182
 calcareia, 71, 167, 181
 incongrua, 71, 180
 krausei, 182, 183, 184
 moesta, 71, 182, 184
 nasuta, 180
 oneilli, 182, 183
 planiuscula, 180
 praetenuis, 180
 macrostigma, Culicoides, 244, 261, 272, 376, 377, 395, 396 (fig.)
 maculata, Odinia, 223, 224, 229, 231, 232
 Pista, 61, 174
 maculithorax, Ceratopogon, 404, 407
 magna, Cylichna, 141
 magnipalpis, Culicoides, 246, 261, 269, 349, 360, 361 (fig.)
 malleata, Strombella, 115
 malleatus, Beringius, 115, 116
 Beringius stumpsoni, 115, 116, 117
 Margarita cinerea, 75
 cinera grandis, 75, 76, 77
 costulata, 81
 sordida, 75
 striata, 75
 vahlhi, 79
 margaritacea, Golfingia, 160
 Margarites, 68, 75, 80
 avenosooki, 68, 77
 cinerea, 75
 costalis, 75
 costalis grandis, 68, 76
 frigidus, 68, 78
 grosvenori, 80
 pribiloffensis, 79
 sordida, 75
 vahlhi, 68, 78, 79
 Margaritopsis, 79
 grosvenori, 67, 68, 80
 pribiloffensis, 68, 79
 mariac, Heliconia, 248, 418
 marshi, Culicoides, 245, 260, 264, 299, 302, 303 (fig.)
 martensi, Colus, 69, 120
 Sipho, 120
 maruim, Culicoides, 289

- Maytenus woodsonii*, 244
mejerei, *Odinia*, 223, 224, 226, 231
mendota, *Brachoria*, 10, 36, 38, 41 (fig.), 42, 57
metagonatus, *Culicoides*, 245, 246, 260, 263, 264, 299, 306 (fig.)
Mezirinae, 209
middendorffiana, *Admete*, 129, 130, 131
 Cancellaria, 130
middendorffiana, *Neptunea*, 69, 122, 123, 124, 126
Milichia boletina, 229
 picta, 232
minuta, *Area*, 150
 Diaphana, 70, 139, 140
 Diaphana minuta, 139
 Leda, 150
 Nuculana, 70, 150
minutus, *Calisiopsis*, 212, 213 (fig.), 221
mirsaе, *Culicoides*, 262, 269, 431, 446 (fig.)
miyamotci, *Culicoides*, 447
Modiola discors, 158
 laevigata, 159
 laevigata substriata, 159, 160
 nigra, 157
Modiolaria corrugata, 158
 discors, 159
 discors laevigata, 159
 discors substriata, 159
 laevigata, 159, 162
 nigra, 157
moesta, *Macoma*, 71, 182, 184
 Tellina, 182
mojingaensis, *Culicoides*, 244, 261, 271, 377, 379, 380 (fig.), 381, 384, 395, 397
molleri, *Montacuta*, 174, 175
 Mysella, 174, 175
Molleria, 81
 costulata, 68, 81
Monoculicoides, subg., 258, 466
Montacuta, 174
 dawsoni, 174
 elvata, 174
 ferruginosa gronlandica, 174
 molleri, 174, 175
 planata, 71, 174
montagui, *Astarte*, 71, 167, 178
 Venus, 167
monterona, *Euspira*, 91
 Polinices, 91
monteronus, *Polinices*, 68, 90, 91
morchianum, *Buccinum*, 102
 Buccinum glaciale, 69, 102, 104
Morvillia undata, 94
multicalcarata, *Aradacanthia*, 209, 210, 212, 213 (fig.)
multicostatus, *Boreotrophon*, 98
 Murex, 98
Murex clathratus, 98
 despectus, 124
 multicostatus, 98
Muricidae, 69, 97
murrayana, *Dendrobenia*, 160
Musculus, 65, 71, 157
 corrugatus, 71, 158, 160, 161
 discors, 71, 159, 161, 162
 discors laevigatus, 71, 159, 160, 161, 162
 laevigatus, 159, 160
 niger, 71, 157, 161
 niger obesus, 157, 158
 sp., 191
Mya, 184
 arenaria, 185, 186, 187, 188
 intermedia, 186, 187, 188
 japonica, 186, 187, 188, 189
 norvegica, 164
 pseudoarenaria, 71, 186, 187, 188, 189
 striata, 164
 truncata, 71, 184, 187, 188, 190
 truncata abbreviata, 184
 truncata ovata, 186, 187, 188
 truncata uddevallensis, 71, 184
Myacidae, 71, 184
myalis, *Nucula*, 70, 152
 Yoldia, 152, 153
myopsis, *Thracia*, 71, 162
Mysella, 173
 molleri, 174, 175
 planata, 174, 175
 sovaliki, 71, 173
 tumida, 174, 175
Mytilidae, 67, 71, 157
Mytilus, 157
 corrugatus, 158
 discors, 159
 edulis, 71, 157
nasuta, *Macoma*, 180
Natica, 90, 169
 clausa, 68, 89, 90
 pallida, 91
Naticidae, 68, 89
nazanensis, *Lora*, 134
 Oenopota, 134
Neoalticomeres, 224
Neptunea, 65, 69, 121
 despecta, 124
 heros, 69, 122, 123, 125, 126
 middendorffiana, 69, 122, 123, 124, 126
 satura, 122, 123
 soluta, 122, 123, 124, 126
 ventricosa, 69, 121, 123, 124, 125, 126
 viosa, 124
Neptuneidae, 66, 69
Nicania banksii, 167
 striata, 167
niger, *Musculus*, 71, 157, 161
nigra, *Modiola*, 157
 Modiolaria, 157
nigrigenus, *Culicoides*, 244, 245, 216, 260, 265, 308, 309 (fig.), 313
nitidula, *Cylichna*, 138
nitidulus, *Utriculus*, 138
noachina, *Patella*, 74
 Puncturella, 68, 74

- Nodotoma, 137
 impressa, 69, 137
 normale, *Buccinum angulosum*, 66, 67,
 69, 109, 110, 111, 112
 norvegica, *Lyonsia*, 71, 164
 Mya, 164
 Nucula, 149
 arctica, 151
 expansa, 149
 hyperborea, 152
 myalis, 70, 152
 tenuis, 70, 149
 tenuis expansa, 149
 Nuculana, 150
 arctica, 67, 70
 minuta, 70, 150
 radiata, 70, 151
 Nuculanidae, 67, 70, 150
 Nuculidae, 70, 149
 Nudibranchia, 143

 Obesotoma, 132
 simplex, 69, 133
 tenuilirata, 69, 132
 sp., 132, 133
 obesus, *Musculus niger*, 157, 158
 obnoxius, *Culicoides*, 454, 456
 obscura, *Solaricella*, 68, 80
 obscurus, *Turbo*, 80
 obsoletus, *Ceratopogen*, 290
 Culicoides, 258
 occidentalis, *Ptychotractus*, 69, 129
 occulta, *Bulla*, 140
 Cylichna, 66, 70, 140
 Cylichna occulta, 141
 ochra, *Brachoria*, 7, 8, 10, 14, 17, 18, 20,
 21, 44, 54, 56
 Brachoria ochra, 9, 10, 11
 Fontaria, 2, 10
 Octopoda, 70, 148
 Octopodidae, 70, 149
 Octopus hokkaidensis, 149
 ocumarensis, *Culicoides*, 280
 Odinia, 223, 224, 225 (key)
 betulae, 224, 226, 230
 biguttata, 225, 226, 228, 230, 231,
 233, 236
 boletina, 223, 226, 229
 conspicua, 224, 225, 228
 coronata, 226, 232, 234, 235, 236
 hendeli, 228
 immaculata, 223, 224
 maculata, 223, 224, 229, 231, 232
 meijerei, 223, 224, 226, 231
 ornata, 223, 224, 231
 parvipunctata, 226, 232, 235
 picta, 223, 226, 229, 232
 trinitata, 224
 williamsi, 223, 226, 232, 234, 235,
 236
 xanthocera, 229
 Odiniidae, 223
 Odostomia, 141
 cassandra, 70, 141
 Oeacta furens, 314, 404
 subg., 258, 260, 261, 262, 308, 314

 Oenopota, 65, 69, 132, 134
 elegans, 69, 135
 harpa, 66, 134
 harpularia, 69, 135
 nazanensis, 134
 tenuicostata, 134
 "Oenopota" *pyramidalis*, 69, 136
 pyramidalis gigantea, 136
 pyramidalis simplicata, 136
 pyramidalis vahli, 136
 oliveri, *Culicoides*, 287
 Onchidiopsis, 92
 glacialis, 68, 92, 93
 groenlandica, 68, 93
 groenlandica pacifica, 68, 93
 oneilli, *Macoma*, 182, 183
 Onychoteuthis fabricii, 148
 Opisthobranchia, 138
 Opisthobranchiata, 66, 70
 orbiculata, *Axinopsida*, 71, 172
 Axinopsis, 172
 originalis, *Tritonium antiquum*, 123
 ornata, *Odinia*, 223, 224, 231
 orotundum, *Buccinum*, 108, 109
 Buccinum pemphigus, 108, 109
 ortizi, *Culicoides*, 372
 ostricolorella, *Euzophora*, 232
 ovata, *Mya truncata*, 186, 187, 188
 ovifera, *Boltenia*, 160

 pachymerus, *Culicoides*, 244, 249, 262,
 264, 314, 454, 456, 458, 459, 460
 (*fig.*), 464
 pacifica, *Limacina*, 142
 Onchidiopsis groenlandica, 68, 93
 Spiratella, 142
 Trophon, 100
 pacificus, *Boreotrophon*, 69, 100, 102
 Trophon, 100
 Pagurus trigonocheirus, 117
 painteri, *Culicoides*, 285, 287
 pallida, *Lunatia*, 91
 Natica, 91
 Polinices, 91
 pallidus, *Polinices*, 68, 90, 91, 92
 pallipes, *Calisius*, 211
 palpalis, *Culicoides*, 274, 278
 pampoikilus, *Culicoides*, 245, 246, 260,
 268, 314, 323, 324 (*fig.*)
 panamensis, *Culicoides*, 244, 245, 248,
 249, 260, 266, 332, 334, 335 (*fig.*),
 339
 Dipteryx, 243
 panamericanus, *Culicoides*, 367
 Pandanus, 247
 Panomya, 189
 ampla, 71, 189, 190
 arctica, 71, 189, 190
 turgida, 189, 190
 subg., 189
 Panopaea arctica, 189
 Panope ampla, 189
 papillosa, *Aeolis*, 145
 papyrifera, *Betula*, 231
 paraense, *Haematomyidium*, 314, 440

- paraensis*, *Culicoides*, 244, 245, 246, 249,
 262, 268, 431, 440, 441 (fig.)
parallelum, *Buccinum glaciale*, 102, 104
parvipunctata, *Odinia*, 226, 232, 235
Patella coeca, 73
 noachina, 74
patulipalpis, *Culicoides*, 244, 246, 261,
 270, 421 (fig.), 424, 426
paucicostata, *Cardita*, 171
 Cardita borealis, 170
 Venericardia, 170
paucienfuscatus, *Culicoides*, 261, 265,
 277, 381, 382 (fig.), 393
Pecten islandicus, 155
Pectinidae, 70, 155
Pelecypoda, 70, 149
Peronidia venulosa, 180
perpusilla, *Phytoliriomyza*, 224
perversa, *Triphora*, 68, 87
perversum, *Cerithium*, 87
perversus, *Trochus*, 87
phaeonotus, *Culicoides*, 245, 260, 268,
 314, 326 (fig.), 334
phlebotomus, *Ceratopogon*, 468, 469
 Culicoides, 245, 246, 248, 249, 262,
 267, 372, 469, 470 (fig.), 473
Phlebotomus, 251
Phytoliriomyza perpusilla, 224
picta, *Milichia*, 232
 Odinia, 223, 226, 229, 232
pictipennis, *Culicoides*, 372
 Psychophaena, 314, 372, 374
pifanoi, *Culicoides*, 244, 246, 248, 261,
 265, 277, 384, 385 (fig.), 416
Pilidium commodum, 93
 radiatum, 93
Piliscus, 93
 commodus, 68, 93
pilosus, *Culicoides*, 244, 260, 268, 328,
 332, 333 (fig.)
Pista maculata, 61, 174
planata, *Montacuta*, 71, 174
 Mysella, 174, 175
 Rocheportia, 174
 Tellimya, 174, 175
planuscula, *Macoma*, 180
plecta, *Brachoria*, 9, 21, 22, 23, 27, 43,
 46 (fig.), 53, 55, 56, 57
plectrum, *Buccinum*, 66, 69, 105
Pleurotoma impressa, 137
 pyramidalis, 136
 pyramidalis jenisseensis, 136
 simplex, 133
 tenuicostata, 134
pleurotomarius, *Fusus*, 136
plicatilis, *Bulla*, 96
 Velutina, 69, 96, 97
Plicifusus, 126
 kroyeri, 69, 126
 verkruzeni, 126, 127, 128
Podocarpus, 244
poikilonotus, *Culicoides*, 244, 260, 267,
 269, 329, 332, 337 (fig.)
Point Barrow, Alaska, Marine Mollusca
 of, 59
polare, *Buccinum*, 66, 69, 108
polaris, *Buccinum*, 108
Polinices, 90, 91, 92, 169
 groenlandicus, 92
 monterona, 91
 monteronus, 68, 90, 91
 pallida, 91
 pallidus, 68, 90, 91, 92
polyoun, *Aleyonidium*, 87
Polyporus sp., 224
Polypus glaber, 149
 hokkaidensis, 149
Populus grandidentata, 229
Portlandia arctica, 151
Poulsenia armata, 243
praetenuis, *Macoma*, 180
pribiloffensis, *Margarites*, 79
 Margaritopsis, 68, 79
Prionodesmacea, 70, 149
propinqua, *Cylichna*, 140
propinquus, *Culicoides*, 329, 332
propiipennis, *Culicoides*, 244, 245, 261,
 268, 407, 411, 412 (fig.), 426
Prosopis, 243
pseudoarenaria, *Mya*, 71, 186, 187, 188,
 189
pseudodiabolicus, *Culicoides*, 280
Pseudopythina, 173
 compressa, 71, 173
 rugifera, 173
Psidium guajava, 243
Psolus, 62, 63
 fabricii, 164
Psychophaena pictipennis, 314, 372, 374
 subg., 314
Ptenoglossa, 83
Pteropoda, 142
Ptychotractus, 129
 ligatus, 129
 occidentalis, 69, 129
 pulehella, *Astarte*, 167
pulicaris, *Culex*, 294
punctatus, *Ceratopogon*, 294
Puncturella, 74
 falklandica, 75
 noachina, 68, 74
Puncturellidae, 68
pusilloides, *Culicoides*, 244, 245, 259,
 263, 290, 291 (fig.)
pusillus, *Culicoides*, 244, 246, 248, 249,
 259, 263, 265, 292, 293 (fig.)
pyramidale, *Buccinum*, 136
pyramidalis, *Bela*, 136
 "Oenopota", 69, 136
 Pleurotoma, 136
Pyramidellidae, 65, 70, 141
Pyrulofusus, 114
 deformis, 69, 114
quadrispinosus, *Scolytus*, 232
Rachiglossa, 97
radiata, *Leda*, 151
 Leda pernula, 151
 Nuculana, 70, 161
radiatum, *Pilidium*, 93
rangeli, *Culicoides*, 245, 246, 261, 273,
 421, 422, 423 (fig.), 426, 445
Raphitoma, 137
 amoena, 67, 69, 137

- recifensis, *Culicoides*, 370
 regina, Admete, 69, 131
 reinhardti, Bulla, 140
 reticulata, Turitella, 86
 reticulatum, Taehyrhynchus, 68, 86
 reticulatus, *Culicoides*, 245, 246, 248, 249, 261, 272, 314, 377, 393 (fig.)
 retusa, Dalbergia, 243
 Retusa, 138
 umbilicata, 70, 138
 Rhinodoglossa, 74
 rhodium, *Buccinum tenue*, 106, 107, 108
 richardsoni, Astarte, 165
 Rimula corica, 75
 Rissoa castanea, 84
 jan-mayeni, 85
 Rissoidae, 65, 68, 84
 Rochefortia beringensis, 175
 grebnitzski, 175
 planata, 174
 rostratus, *Culicoides*, 246, 260, 264, 299, 301, (fig) 304
 rozebooni, *Culicoides*, 274, 276
 rugifera, *Pseudopythina*, 173
 rugosa, Hiatella, 191
- Sabrosky, Curtis W.; Flies of the genus *Odinia* in the Western Hemisphere (Diptera: *Odinidae*), 223
 salicis, *Calius*, 209
 salmonacea, *Coryphella*, 70, 145
 Eolis, 145
 Saperda sp., 232
 sapotilla, Yoldia, 153
 sarsi, *Thyasira flexuosa*, 71, 171, 172
 sarsii, *Axinus*, 171
 satura, Neptunea, 122, 123
 saturum, *Buccinum*, 121
 saturus, *Chrysodomus*, 121, 123
 Saxicava arctica, 190
 Scalaria greenlandica, 83
 scarlariformis, *Boreotrophon clathratus*, 98
 Fusus, 98
 Trophon, 97, 98
 scalpta, Bulla, 140
 Cyllichna occulta, 141
 scammoni, *Liocyma*, 177, 178, 179
 Scaphandridae, 70, 140
 schefferi, *Liocyma*, 177, 178, 179
 Schildomyia, 224
 schneideri, *Velutina*, 95
 Velutina velutina, 95
 scissurata, Yoldia, 70, 154
 Scolytus quadrispinosus, 232
 sp., 232
 scopus, *Culicoides*, 245, 246, 260, 266, 314, 347, 348 (fig.)
 Scotobates calcaratus, 229
 sp., 229
 Selfia, subg., 258
 semiplicata, *Bela pyramidalis*, 136
 "Oenopota" *pyramidalis*, 136
 semisulcata, Astarte, 165
 separanda, *Brachoria*, 2, 5, 9, 11, 15, 16, 17, 20, 21, 22, 23, 31, 33, 34, 43, 44, 46 (fig.), 52, 53, 54, 56, 57
- sequens, *Brachoria*, 2, 10, 11, 14, 15
 Serripes, 176
 groenlandicus, 176
 grönlandicus, 71, 176
 Sigmoria, 4, 52
 simplex, *Bela*, 133
 Obesotoma, 69, 133
 Pleurotoma, 133
 Siphon kroyeri, 126
 martensi, 120
 sittkensis, *Velutina*, 96, 97
 Solariella, 80
 obscura, 68, 80
 solitaria, *Cyllichna*, 140
 soluta, Neptunea, 122, 123, 124, 126
 solutum, *Buccinum*, 122, 124, 125, 126
 solutus, *Chrysodomus*, 122, 123, 124, 126
 sordida, Margarita, 75
 Margarites, 75
 sovaliki, Mysella, 71, 173
 spectabilis, *Trichotropis bicarinata*, 88
 spirata, Diaphana, 139
 Spiratella, 142
 helicina, 70, 142
 pacificia, 142
 Spiratellidae, 70, 142
 spitzbergensis, Colus, 119
 spitzbergensis, Colus, 69, 119
 Fusus, 119
 splendida, *Brachoria*, 9, 46 (fig.), 47, 54, 55, 56
 Cleptoria, 2, 6, 47
 Kleptoria, 2
 Tucoria, 47
 spurius, *Culicoides*, 244, 262, 271, 431, 433, 434 (fig.)
 stefanssoni, *Volutopsius*, 69, 128
 stellifer, *Culicoides*, 370
 stigmalis, *Culicoides*, 245, 249, 262, 265, 314, 466, 467 (fig.)
 stimpsoni, Beringius, 66, 69, 115
 Beringius stimpsoni, 117
 Buccinum, 115
 stolonata, Coriella, 147
 Stomphia coccinea, 164
 Streptoneura, 73
 striata, Astarte, 167
 Astarte montagui, 167, 168
 Bulla, 140
 Hiatella, 191
 Margarita, 75
 Mya, 164
 Nicania, 167
 striatum, *Buccinum undatum*, 69, 114
 strigella, *Cyllichna*, 138
 Strombella malleata, 115
 Strongylocentrotus drobachiensis, 124
 stubalensis, *Culicoides*, 370
 subangulata, Bulla, 139
 subangulatus, Utriculus, 140
 subcostatum, *Buccinum angulosum*, 66, 67, 69, 109, 110, 111, 112
 substriata, *Modiola laevigata*, 159, 160
 Modiolaria discors, 159
 Symmetrogephyrus, 147
 vestitus, 70, 147
 Syncoryne sp., 99, 100

- Tachyrhynchus*, 86
 erosum, 86
 reticulatum, 68, 86
Taenioglossa, 83
Tapes fluctuosa, 171, 177
Tapetidae, 71, 177
Taxodonta, 149
Tectibranchiata, 138
Teleodesmacea, 71, 164
Teleodonta, 177
Tellimya planata, 174, 175
Tellina, 180
 calcarca, 181
 flexuosa, 171
 incongrua, 180
 lutea, 71, 180
 lutea venulosa, 180
 moesta, 182
 subg., 182
Tellinidae, 67, 71, 180
tenebrans, *Anfraetogon*, 2, 3, 7, 8, 48
 Brachoria, 10, 17, 47, 51 (fig.), 54, 56
tenue, *Buccinum*, 66, 69, 103, 106, 107
tenuicostata, *Bela*, 134
 Oenopota, 134
 Pleurotoma, 134
tenuilirata, *Bela*, 132
 Lora, 132
 Obesotoma, 69, 132
tenuilobus, *Culicoides*, 244, 260, 267, 316, 349, 351, 354 (fig.)
tenuis, *Arca*, 149
 Nucula, 70, 149
tetrathyrus, *Culicoides*, 244, 261, 269, 407, 409, 410 (fig.), 414, 426
Thracia, 162
 adamsi, 71, 163
 curta, 162, 163
 myopsis, 71, 162
 subg., 163
Thraciidae, 71, 162
Thyasira, 171
 flexuosa, 71, 171
 flexuosa gouldi, 171, 172
 flexuosa sarsi, 71, 171, 172
 gouldi, 171
Thyasiridae, 71, 171
Toxoglossa, 129
Trachydermon, 145
 albus, 70, 145
Traginops, 224
transferrans, *Culicoides*, 245, 246, 261, 273, 314, 421, 422, 424, 425 (fig.), 445
 group, *Culicoides*, 261, 420
transliratum, *Buccinum angulosum*, 66, 69, 109, 111, 112
Tricellaria erecta, 159, 191
Trichotropidae, 63, 88
Trichotropis, 66, 68, 88
 bicarinata, 68, 88
 bicarinatasalta, 88
 bicarinata spectabilis, 88
 borealis, 68, 88
 kroyeri, 68, 89
tricoloratus, *Culicoides*, 384, 386
trigonocheirus, *Pagurus*, 117
trilineatus, *Culicoides*, 445
trinidadensis, *Culicoides*, 245, 246, 248, 249, 259, 263, 280, 287, 288 (fig.)
trinitata, *Odinia*, 224
Triphora, 87
 perversa, 68
Triphoridae, 68, 87
Tritonium, *antiquum*, 123
 antiquum behringiana, 123
 antiquum communis, 123
 antiquum originalis, 123
 behringii, 117, 118
 beringii, 118
 carinatum, 102
 ciliatum, 113
 gunneri, 98
 subg., 129
Trochidae, 66, 68, 75
Trochus costalis, 75
 perversus, 87
Trophon, 101
 bamfinus, 97
 beringi, 99
 clathratus, 97, 98
 clathratus gunneri, 98
 pacifica, 100
 pacificus, 100
 scalariformis, 97, 98
 truncatus, 101
truncata, *Mya*, 71, 184, 187, 188, 190
truncatum, *Buccinum*, 101
truncatus, *Boreotrophon*, 69, 100, 101
Tucoria, 1, 3, 4, 6, 7, 20, 40, 42, 50, 52
 calceata, 2, 6, 16
 dynama, 2, 6, 47, 48
 kentuckiana, 38
 splendida, 47
 viridicolens, 2, 6, 50, 52
tumida, *Mysella*, 174, 175
Turbo bicarinatus, 88
 cinereus, 75
 corneus, 75
 obscurus, 80
turgida, *Panomya*, 189, 190
Turitella reticulata, 86
turneri, *Brachoria*, 6, 7, 10, 49, 51 (fig.), 53, 55, 56
turneri, *Aquilonaria*, 68, 83, 84
Turridae, 65, 66, 69, 132
Turritellidae, 68, 86
uddevallensis, *Mya truncata*, 71, 184
umbilicata, *Bulla*, 138
 Retusa, 70, 138
umbilicatus, *Utriculus*, 138
undata, *Morvillia*, 94
 Velutina, 69, 94, 97
undatum, *Buccinum*, 69, 114, 126
undecimpunctatus, *Culicoides*, 440
Ungulinidae, 71, 172
uniradialis, *Culicoides*, 244, 245, 246, 262, 264, 454, 456, 461, 462 (fig.)
Utriculus candidus, 139
 expansus, 139
 nitidulus, 138
 subangulatus, 140
 umbilicatus, 138

- vahli, Margarita, 79
 Margarites, 68, 78, 79
 "Oenopota" pyramidalis, 136
 vahlii, Defrancia, 136
 variciferus, Chrysodomus, 121, 122
 Chrysodomus solutus, 121, 122
 variipennis, Culicoides, 466
 velutina, Bulla, 95
 Velutina, 69, 95, 97
 Velutina, 94
 coriacea, 97
 cryptospira, 96
 laevigata, 95
 lanigera, 69, 97
 plicatilis, 69, 96, 97
 plicatilis cryptospira, 96
 schneideri, 95
 sitkensis, 96, 97
 undata, 69, 94, 97
 undata zonata, 94, 95
 velutina, 69, 95, 97
 velutina schneideri, 95
 zonata, 94
 Venericardia alaskana, 169
 crassidens, 170
 crebricostata, 169
 paucicostata, 170
 venezuelensis, Culicoides, 246, 261, 267,
 268, 314, 363, 372, 373 (fig.)
 ventricosa, Cardita, 169
 Neptunea, 69, 121, 123, 124, 125,
 126
 ventricosum, Buccinum, 121
 venulosa, Peronidia, 180
 Tellina lutea, 180
 Venus compressa, 167
 flexuosa, 171
 fluctuosa, 177
 montagui, 167
 verecundus, Culicoides, 244, 248, 259,
 263, 274, 278, 279 (fig.)
 verkruzeni, Fusus, 126
 Plicifusus, 126, 127, 128
 vestitus, Amicula, 147
 Chiton, 147
 Symmetrogephyrus, 70, 147
 vinosus, Chrysodomus, 124
 viosa, Neptunea, 124
 viridicolens, Brachioria, 58, 50, 51 (fig.),
 54, 55, 56
 Tucoria, 2, 6, 50, 52
 viridis, Axinopsida, 172
 Liocyma, 177, 178, 179
 viridula, Cancellaria, 129
 volcanensis, Culicoides, 246, 261, 270,
 273, 377, 389 (fig.)
 Volutopsius, 128
 behringi, 116
 beringi, 117, 119
 beringii kobelti, 117, 118
 kobelti, 117
 stefanssoni, 69, 128
 warhami, Astarte, 167
 Astarte montagui, 167, 168
 williamsi, Odinia, 223, 226, 232, 234,
 235, 236
 willistoni, Culicoides, 245, 246, 262, 267,
 372, 469, 471, 472 (fig.)
 Wirth, Willis W., and Blanton, Frank-
 lin S.; Biting midges of the genus
 Culicoides from Panama (Dip-
 tera: Helicidae), 237
 wokei, Culicoides, 245, 246, 271, 288,
 290, 363, 364 (fig.), 401
 woodiana, Defrancia, 135
 woodsonii, Maytenus, 244
 xanthocera, Odinia, 229
 Xystodesmidae, 1, 6, 20
 Yoldia, 151
 arctica, 151
 arctica lutescens, 151, 152
 ensifera, 154
 hyperborea, 70, 152
 hyperborea limatuloides, 153, 154
 limatula, 153, 154
 myalis, 152, 153
 sapotilla, 153
 scissurata, 70, 154
 zetlandica, Aldisa, 70, 143
 Doris, 143
 zonata, Velutina, 94
 Velutina undata, 94, 95

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 01420 9910